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An Annotated Bibliography to Network Data Management and Related Literature

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Introduction

This bibliography has been prepared in parallel with a report on the state-of-the-art in network data management and related technology. Both of these projects are subtasks in the development of a three year research plan to develop networking technology. They are motivated by the need for a sound review of current technology, including an assessment of future needs, on which to base future research activities.

Emphasis has been on current ideas and recent work. The reader will notice few references in the bibliography that are more than seven years old. However, an attempt has been made to include key review papers which provide a guide to the older literature. The reader should also be warned that this bibliography was prepared under severe time constraints, so that coverage of the literature is not as complete as desired. This is particularly true in areas which are somewhat peripheral to the main research thrust: distributed data management. However, at least the key papers on each topic are included, so that the reader should have no trouble locating relevant papers which may have been omitted from this list. Future editions of this bibliography are expected.

In order for these future editions to be complete and up-to-date, the authors would be grateful to receive copies of any relevant documents which either have been inadvertently omitted here or have been produced since this bibliography was prepared.

The bibliography is organized into two sections: a master list section with all entries arranged alphabetically by author and a second section with entries arranged in three major topic areas: data management, network and systems environment, and network application support. Each of these major areas is divided into subtopics.

The data management area is divided into seven subtopics. The first includes work on data structures - tabular structures, complex structures, accessing methods, modeling and evaluation of data organizations and of complete information systems, etc. Following these references are references on techniques for handling data efficiently - hashing, clustering, and compression. The last subtopics under data management are data languages (references ranging from languages used to specify physical data structures to experiments in resolving ambiguities in queries stated in natural language), data integrity (consistency checking, authorization, problems of concurrent use, etc.) and file allocation (with particular emphasis on the distribution of files in a network).

The second large area deals with networks, operating systems, and the general environment of the distributed data base. The large subtopic on communications and networks includes an extensive listing of work on communications technology, network topologies, theoretical network analysis, and network design. Other subtopics list references on resource allocation and control (including protocols, flow control, and routing), systems measurement and analysis, network access systems and front-ends, and security.

The third large area deals with application support on a network. It is somewhat arbitrarily divided into three subtopics - user support (including documentation, mail, and teleconferencing), management support (primarily accounting and aids to project scheduling), and network support (including subnet maintenance and evaluation).

Many of the references, particularly for the third major area, are working documents from the ARPA network development. These working papers are identified by their Request For Comments number (RFC #xxx) and/or their Network Information Center number (NIC #xxx). Items marked with a NIC number have been archived by the ARPA Network Information Center ((415) 329-0740) at the Stanford Research Institute's Augmentation Research Center in Menlo Park, California (94025). Items marked with an RFC number are included in a series of Requests for Comments maintained at the NIC by the ARPA Network Working Group (NWG).

The references contain citation data to locate the document, a list of key phrases enclosed in square brackets, and a short annotation which briefly describes the contents of the document. No attempt has been made to rank the references by quality or importance.

The subtopic bibliographic lists were computer generated based on a set of key phrases for each subtopic. In a few cases, some references were mistakenly included in or excluded from a subtopic. The worst of these mistakes were corrected by manipulation of the key phases. However, minor errors still exist. It is hoped that these will be corrected in future editions.

This report was the result of a large team effort by research and clerical staff. Shirley Brown, Pam Leasure, and Sue Haag were responsible for entering and editing the annotations in the computer system used to print the bibliographic lists.

Abramson, N., "Packet Switching with Satellites", AFIPS NCC, 1973, pp. 695-702.
[Packet Communication, Packet Radio, Satellite Communication]

The history of packet communication and the ALOHA Network are briefly presented. The ALOHA channel capacity and excess channel capacity results are derived. The properties of satellite channels are discussed in some detail, and current satellite communication experiments in progress among NASA Ames Research Center, University of Alaska, and University of Hawaii are described. A strong argument is given for a domestic satellite-based packet network.

Ackerman, W., Plummer, W., "An Implementation of a Multiprocessing Computer System", Proceedings ACM Symposium on Operating System Principles, 1967.
[Protection, Resource Allocation, Process Synchronization, Timesharing]

A multi-processing system implemented on a PDP-1 is discussed. Principal design criteria were: supervisor modularity through independent and synchronous processes; user mode process control of I/O functions; and an effective scheme for allocation and protection of system resources. Protection is implemented by a capability list (C-list) associated with each computation. Multi-processing primitives (meta-instructions), are discussed in detail in relation to interrupt handling, protection, I/O, and process control.

Aho, A.V., Denning, P.J., Ullman, J.D., "Principles of Optimal Page Replacement", JACM 18, Jan. 1971.
[Measurement, Performance Evaluation, Paging]

This paper develops a formal statistical model of program behavior in a paging environment. The paper considers various paging algorithms and cost relations.

Akkoyunlu, E., Bernstein, A., Schantz, R., "Interprocess Communication Facilities for Network Operating Systems", Computer, June 1974, pp. 46-55.
[Inter-process Communication, Ports]

The desirability of flexible interprocess communication (IPC) facilities in a network operating system is established, and three such facilities are described. They are Walden's IPC scheme (CACM 15, Apr. 1972), DCS (University of Calif. at Irvine), and SBS (State University of New York at Stony Brook).

Akkoyunlu, E., Bernstein, A., Schantz, R., "Software Communication Across Machine Boundaries", IEEE COMPCON73, 1973, pp. 203-205.
[Interprocess Communication, Data Port, Thin Line Communication, Modularity, Co-operating Processes]

The software communication facility for an operating system designed to function as part of a computer network is described. The facility is implemented as data ports and allows a process to control information flow between itself and other objects (e.g., files and processes) by using a uniform set of primitives, without regard to the actual location of the object in the network.

Akkoyunlu, R., Bernstein, A., Schantz, R., "An Operating System for a Network Environment", Department of Computer Science, SUNY at Stony Brook, Tech. Rept. #5.
[Front-end Processor, Ports]

This paper describes a layered operating system based on the inter-process communication techniques of Walden and Balzer to be built on a PDP-15. The system is layered along interesting lines: logical, data port, known item, and user levels.

Alsberg, P., Day, J., Purdy, G., "Automated Resource Sharing on the ARPA Network", Center for Advanced Computation Report, Univ. of Ill., May 1973.
[Automated Resource Sharing, ARPANET, Distributed Computing, Security, Name Space Management, File Access Protocols, Process Control Protocols]

The design of a network-based distributed computing system to take advantage of some unique, heterogeneous resources available to the Center for Advanced Computation over the ARPANET is discussed. Four problems currently impeding the use of the ARPANET as a resource sharing utility--network security, name space management, file access protocols, and process control protocols, are discussed. In addition, a security coding system to control resource sharing is described.

Alsberg, P.A., "Project Dileptus--A Study of Distributed Computing", Center for Advanced Computation, University of Illinois, Dec. 1973 (draft).
[Distributed Computing, Protocol, Measurement, Process Control, Data Transfer]

The purpose of the Dileptus Project is to study the fundamental relationships involved in distributed systems, to empirically verify these relationships and to develop suitable protocols for distributed computing on the ARPA Network. Of particular interest is the harmonious co-operation of dissimilar machines in a hostile environment. Each component of the system must be suspicious of the correct functioning and good will of its multiple neighbors.

Alsberg, P.A., "Distributed Processing on the ARPA Network--Measurements of the Cost and Performance Tradeoffs for Numerical Tasks", Proc. Eighth Hawaii Internat'l Conference of System Sciences, 1975.
[Measurement, ARPANET, Resource Sharing, Performance Benchmark]

A benchmark of the cost (including network costs) and speed of a tyoical numerical computation (matrix inversion) for seven different machines on the ARPANET shows that distributed computing pays off earlier than first expected. Rough trends are also given for operations such as file management, console handling, bit flogging, and character manipulation. This paper is one of the first to actually show that distributed computation is cost effective.

Alsberg, P.A., Mills, C., "The Structure of the ILLIAC IV Operating System", Second ACM Symposium on Operating System Principles, Oct. 1969, pp. 92-96.
[Resource Allocation, Modularity]

The structure of the ILLIAC IV operating system is outlined in relation to system design goals.

Anderberg, M.R., "Cluster Analysis for Applications", Academic Press, 1973.
[Data Clustering, Data Partitioning]

This book serves as a good introduction and guide to the literatuure of clustering techniques--linked, hierarchical, etc. Because of the enormous size of the clustering literature, this bibliography will otherwise omit work not directly dealing with data base applications.

Anderson, R., Cerf, V., Harslem, E., Heafner, J., Madden, J., Metcalfe, R., Shoshani, A., White, J., Wood, D., "Status Report on Proposed Data Reconfiguration Service", RFC 138, NIC 6715, April 1971.
[Data Reconfiguration, Protocol]

One approach to providing specific data I/O format adaptation is for those sites with substantial computing power to offer a data reconfiguration service--a proposed example of such a service is described.

Anderson, R., Cerf, V., Harslem, E., Heafner, J., Madden, J., Metcalfe, R., Shoshani, A., White, J., Wood, D., "Data Reconfiguration Service--An Implementation Specification", RFC 166, NIC 6780, May 1971.
[Data Reconfiguration, Protocol, Language]

This paper gives the specifications of the Data Reconfiguration Service (DRS), which is a software mechanism to reformat Network data streams.

Arden, B., Boettner, D., "Measurement and Performance of a Multiprogramming Systems", Proc. Second Symposium on Operating System Principles, Princeton, 1969, pp. 130-146.
[Measurement, Performance Evaluation]

This paper discusses various measures of performance performed on the University of Michigan MTS System. The paper contains some very interesting and helpful graphs and data of the measurements made.

Arora, S.R., Dent, W.T., "Randomized Binary Search Technique", CACM 12, 1969, pp. 77-80.
[Data Structures, Data Trees]

A natural ordering of records is assumed and a tree structure is set up (based on the "greater than", "less than" binary choice) as the records are received in random order. A mathematical model for this process is set up and analyzed.

Arora, S.R., Gallo, A., "The Optimal Organization of Multiprogrammed Multi-Level Memory", Proc. ACM Workshop on System Performance Evaluation, 1971, pp. 104-141.
[Measurement, Performance Evaluation, Queueing Theory]

This paper combines a cyclic queueing model and a linear optimization model to investigate cost and throughput issues. The paper derives several interesting results with respect to effects of multiprogramming on response time, cost, and throughput capacity.

Arora, S.R., Gallo, A., "Optimal Sizing, Loading, and Re-loading in a Multi-level Memory Hierarchy System", AFIPS SJCC 38, 1971, pp. 337-344.
[File Allocation]

On the assumption of a very simple model (no queueing delays) the authors "prove" that the most accessed blocks should be loaded into the fastest memory. An algorithm for optimal sizing of the levels (given a typical program mix) is discussed. A unique feature is a paragraph on dynamic allocation.

Artaud, A., Nicolas, J.M., "An Experimental Query System: Synton", International Computing Symposium, 1973, pp. 557-563.
[Data Structures]

A two level data management system is described. At the lower level, atoms and relations are used to define elementary information. At the upper level, axioms are used to define the data structure.

Ash, W.L., Sibley, E.H., "TRAMP: An Interpretive Associative Processor with Deductive Capability", Proc. ACM, 1968, pp. 143-156.
[Associative Processing]

An "associative memory" is used to facilitate operations on binary relations. A deductive system is implemented using the binary relations. Hash coding is used to implement the "associative memory".

Astrahan, M.M., Chamberlin, D.D., "Implementation of a Structured English Query Language", IBM Technical Report RJ 1464, 1974.
[Relational Data System, Query Language]

The implementation of a relational query language, SEQUEL, is described. It has been implemented using a prototype interpreter design to minimize accessing operations. The optimization algorithms are described.

Aupperle, E., "MERIT Computer Network: Hardware Considerations", Computer Networks, R. Rustin, ed., Prentice Hall, 1972, pp. 49-63.
[MERIT, Centralized System, Distributed System, Communications Processor, Front End Processor, Telecommunications]

The configuration chosen for the MERIT Computer Network is discussed in comparison with alternative choices, and the direction of future techniques of operation is outlined. The principal aspects of the hardware--the communications computer, the telephonic communications, and the interfaces--are described in detail.

Balzer, R.M., "PORTS - A Method for Dynamic Interprogram Communications and Job Control", AFIPS SJCC, 1971, pp. 485-489.
[Inter-process Communication, Thin-line Communication]

A unified approach to communication between processes and all entities external to the process is presented. PORTS is a co-routine-like mechanism that permits processes to obtain input data and produce output results independent of the source or destination, respectively.

Baskett, F., Muntz, R.R., "Queueing Network Models with Different Classes of Customers", IEEE COMPCON72, 1972, pp. 205-209.
[Queueing Network, Network Modeling, Queueing Theory, Network Performance]

Four different types of service centers are handled, and steady state equations are obtained. The model includes considerations for different types of customers with different priorities. An example which resembles a CPU with four I/O devices is studied, and graphs for amount of utilization of each service center (vs. number of customers) are given.

Baskin, H., Borgerson, B., Roberts, R., "PRIME--A Modular Architecture for Terminal Oriented Systems", AFIPS SJCC 40, 1972, pp. 431-437.
[Operating System, Multi-processing, Security, Error Detection, Error Recovery, Time Sharing, Computer Hardware, Reliability]

In this system a basic assumption is that failures exist as a normal occurence, rather than a special state, and they must be treated while continuing as near normal operation as possible. PRIME is a modular, canonical system consisting of n identical subsystems which can process n independent jobs with a high degree of protection from each other.

Baskin, H., Horowitz, E., Tennison, R., Rittenhouse, L., "A Modular Computer Sharing System", CACM 12, Oct. 1969, pp. 551-559.
[Operating System, Multi-processing, Security, Error Detection, Error Recovery, Time-sharing, Computer Hardware]

The system organization used is a bank of interchangeable computers, each consisting of a memory/processor pair, which are assigned to process terminal jobs as they arrive. One computer serves as master and supervises collection and distribution of messages from and to remote terminals. In simplest form, each computer has associated with it a disk drive assigned under control of the master computer.

Bauer, M.J., McCredie, J.W., "AMS: A Software Monitor for Performance Evaluation and System Control", Proc. First Annual SIGME Symposium, ACM, 1973, pp. 147-160.
[Measurement, Performance Evaluation, Load Measures]

This paper describes a software monitor system that collects statistics on system load parameters. These measures are then used to dynamically tune the allocation of system resources.

Baum, R.I., Hsiao, D.K., "A Semantic Model for Protection Mechanisms in the Data Base System", Eighth Hawaii Int'l. Conf. on System Sciences, 1975, pp. 175-179.
[Access Control, Data Security]

Given a data base, the relationships which exist between items in the data base, and the fact that a certain user is not to gain knowledge of certain items, this paper presents a variety of protection methods which vary in complexity of implementation and the total amount of information withheld.

Bell, J.R., "The Quadratic Quotient Method: A Hash Code Eliminating Secondary Clustering", CACM 13, 1970, pp. 107-109.
[Hashing]

This paper discusses the secondary clustering which occurs in the quadratic hash method and shows how it may be eliminated by modifying the method. Both analytical and empirical comparisons are made with other methods.

Bell, J.R., Kaman, C.H., "The Linear Quotient Hash Code", CACM 13, 1970, pp. 675-677.
[Hashing]

This paper presents a new algorithm for handling hashing collisions as well as computing the original hash address. The algorithm seems to be simple and efficient and appears to perform well in simulation tests. Clustering is not discussed.

Belsnes, D., "Flow Control in Packet Switching Networks", InterNetwork Working Group Note #63, Oct. 1974.
[Flow Control, Packet Communication, Congestion]

A discussion is given of the window scheme, an end-to-end untested flow control mechanism, and their possible advantages to a network.

Benoit, J.W., Graf-Webster, E., "REX--A Resource Location and Acquisition Service for the ARPA Computer Network", MITRE Technical Report #387, January 1974, MITRE Corp., McLean, Va.
[ARPANET, Command Language, Distributed Computing, Documentation, Network Accounting, On-line Documentation, Resource Sharing]

Several existing resource sharing systems on the ARPANET are briefly described, and some basic needs of a resource sharing system are discussed. The REX system is described. REX is a system which allows a user to locate a desired resource on the net. This is done using local files. No host-host communication is required.

Bensoussan, A., Clingen, C., Daley, R., "The MULTICS Virtual Memory", ACM Second Symposium on Operating Systems Principles, October 1969, pp. 30-42.
[MULTICS, Virtual Memory, Access Control, Data Sharing, Segmentation, Paging, Address Space]

Design and implementation considerations of segmentation and paging in MULTICS are discussed in detail. It is shown how the MULTICS supervisor, in conjunction with the GE 645 segmentation and paging hardware, utilizes the virtual memory.

Berggreen, A., "Interfacing an Illinois Plasma Terminal to the ARPANET", RFC 600, Nov. 1973.
[Graphics, Intelligent Terminals, Terminals]

This paper describes the hardware involved for interfacing a PLATO terminal to the ARPANET. The difficulties arise from the non-standard nature of the PLATO interface.

Berman, G., Colijn, A.W. , "A Modified List Technique Allowing Binary Search", CACM 21, 1974, pp. 227-232.
[Data Structuring, Retrieval Strategies]

This paper proposes a modified linked-list structure, in which consecutive list elements are placed in a block of consecutive memory locations whenever possible. Binary searches may then be used on these blocks.

Bernstein, A., Deflefsen, G., Kerr, R., "Process Control and Communication", ACM Second Symposium on Operating Systems Principles, October 1969, pp. 60-66.
[Interprocess Communication, Process Control, Co-operating Processes]

The structure of processes within a general purpose operating system and primitives available for process control and inter-process communication are described.

Berra, P.B., "Some Problems in Associative Processor Applications to Data Base Management", AFIPS Conf. Proceedings 43, 1974, pp. 1-5.
[Associative Memory]

This is a brief, up-to-date review of research into associative devices and their application to handling data bases.

Betourne, C., Boulenger, J., Ferrie, J., Kaiser, C., Kott, J., Krakowiak, S., Mossiere, J., "Process Management and Resource Sharing in the Multiaccess System 'ESOPE'", ACM Second Symposium on Operating Systems Principles, October 1969, pp. 67-74.
[Resource Sharing, Process Control, Process Synchronization, File System Design, Virtual Memory, Resource Allocation]

Process management, virtual memory, file system organization, memory allocation, and user scheduling are discussed generally in relation to the main design principles of the multiaccess system ESOPE. No actual implementation details are given.

Bhushan, A., "Data and File Transfer--Some Measurement Results", RFC 573, Sept. 1973.
[File Transfer Protocol, Network Measurement]

This RFC describes results of file transfer measurements on the ARPANET between the MIT-DMS system (a PDP-10) and five other PDP-10's on the network (with either TENEX or ITS operating systems). The measurements are primarily of transfer rate, response time, cost, and availability.

Bhushan, A., Braden, R., Crowther, W., Harslem, E., Heafner, J., McKenzie, A., Melvin, J., Sundberg, R., Watson, R., White, J., "The Data Transfer Protocol", RFC 264, NIC 7812, Nov. 1971.
[Data Transmission, Protocol, Remote Job Entry]

Although it would be possible to include some or even all applications in an all-inclusive file transfer protocol, a separation between data transfer and application functions may provide flexibility in implementation, and reduce complexity. The authors have defined a data transfer protocol (DTP) which should be used for transfer of all data in file transfer, remote job entry, and other applications protocols.

Bhushan, A., Ryan, N., "Using MIT-MATHLAB MACSYMA from MIT-DMS MUDDLE--An Experiment in Automated Resource Sharing", NIC #19501.
[Automated Resource Sharing]

This paper describes an experiment in nontrivial automated resource sharing between the MUDDLE system at MIT-DMS and the MACSYMA system at MIT-MATHLAB in such a manner that the MUDDLE-user is not required to know anything about the ARPA Network, MATHLAB, or even MACSYMA.

Bhushan, A.K., "FTP and Network Mail System", RFC #475, Mar 1973.
[Mail, FTP, User Support]

This paper contains another view of a Network Mail Meeting held in March, 1973 (see RFC 469). This paper considers the points made at the meeting and their implications to the File Transfer Protocol. Bhushan discusses access control, mail to TIP's, mail use scenarios, and other topics discussed at the meeting. This paper makes a good companion to Kudlick's discussion of the same meeting.

Bitzer, D.L., Slottow, H.G., "The Plasma Display Panel--A Digitally Addressable Display with Inherent Memory", AFIPS FJCC, 1966, p. 541.
[Graphics, Terminal Technology, Terminal]

Written while the plasma panel was still in an experimental stage, this paper describes the operation of that device, and contrasts it with a CRT screen.

Bjorner, D., Codd, E.F., Deckert, K.L., Traiger, I.L., "The GAMMA-0 n-ary Relational Data Base Interface Specifications of Objects and Operations", IBM Research Report RJ 1200, 1973.
[Relational Data System]

GAMMA-0, a low level interface for the manipulation of a relational data base is described. It is intended to be used as a base for implementing higher level interfaces.

Blanc, R., "Availability and Usability of Computer Communication Networks", Seventh Hawaii International Conference on System Sciences - Subconference on Computer Networks, 1974.
[Distributed System, Front-end Processor, Remote Job Entry]

This paper presents a general survey of some considerations in network evaluation and selection.

Blanc, R.P., "Review of Computer Networking Technology", NBS Technical Note 804, National Bureau of Standards, Jan. 1974.
[Network, TYMNET, CYBERNET, GE Information Services, MERIT, ARPANET, TSS Network]

This report gives a short overview and description of current network Technology, then describes and performs cursory analyses of several existing networks.

Bleier, R.E., "Data Definition Standardization", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1970, pp. 68-86.
[Data Definition Language]

The data definition languages (DDL) of a few general-purpose systems are described. Also, attributes of data that should be considered in a standard DDL are mentioned.

Bloom, B.H., "Some Techniques and Tradeoffs Affecting Large Data Base Retrieval Times", Proceedings ACM Twenty Fourth National Conf., 1969, pp. 83-95.
[Data Structuring, File System Design, Retrieval Strategies]

An analysis of retrieval-time savings from the use of inverted files is given. The corresponding increase in update time and the further savings that may be accomplished by compression of the inverted file are also discussed.

Bobrow, R., "An Experimental Data Management System", Data Base Systems, R. Rustin, ed., Prentice-Hall, 1972, pp. 125-141.
[Data Structures]

It is shown that a relational structure is inherent in EDMS (Experimental Data Management System) even though it uses the object-oriented network viewpoint and not a true relational point of view. The network viewpoint is convenient for expressing certain implementation strategies, and restrictions on the permissible network structures allow efficient search strategies. The relational point of view makes it possible to express a large number of queries in a uniform language.

Bolt, Beranek, and Newman, Inc., "Specifications for the Interconnection of a Host and an IMP", Report #1822, Bolt, Beranek, and Newman, Inc., Cambridge, Ma.
[Protocol, IMP, IMP-Host Protocol, Host-IMP Protocol, Communications Equipment, ARPANET, Packet Communication]

This report describes the physical, hardware, and software environment a computer site must establish to connect to the ARPANET via a BBN Interface Message Processor. IMP-HOST and HOST-IMP message leader formats are described for the implementer of HOST-IMP communications software. Hardware interface specifications are given for the implementer of interface hardware. This document is periodically updated to reflect hardware/software changes in the IMP.

Booth, G.M., "The Use of Distributed Data Bases in Information Networks", First Int'l. Conf. on Computer Communication, 1972, pp. 371-376.
[Distributed System, Data Management Overview]

This paper talks about problems associated with several aspects of distributed data bases, as well as various solutions to those problems and implications of the solutions.

Bouknight, W.J., Grossman, G.R., Grothe, D.M., "The ARPA Network Terminal System: A New approach to Network Access", Center for Adv. Comp., Univ. of Ill., Urbana, Ill.
[ARPANET, Front-end Processor, Operating Systems]

This paper describes an operating system developed for a PDP-11 as an access medium to the ARPANET. The layered system uses a line-switched oriented interprocess communication method between special processes designed to handle multiple users in a unique way.

Boyce, R.F., Chamberlin, D.D., "Using a Structured English Query Language as a Data Definition Facility", IBM Research Report RJ 1318, 1973.
[Data Definition Language]

A data definition language for a relational data base is proposed. Included are facilities for specifying alternate views of the data, rules for data conversion, and integrity constraints.

Boyce, R.F., Chamberlin, D.D., Hammer, M.M., King, W.F., "Specifying Queries as Relational Expressions", Proc. ACM SIGPLAN-SIGIR Interface Meeting, 1975, pp. 31-38.
[Query Languages, Relational Theory]

The authors present SQUARE, a set oriented data sublanguage. SQUARE attempts to mimic how people use tables to obtain iformation.

Bracchi, G., Fedeli, A., Paolini, A., "A Language for a Relational Data Base Management System", Proc. Sixth Annual Princeton Conf. on Information Sciences and Systems, 1972, pp. 84-92.
[Relational Query Language]

This paper illustrates COLARD, which is a non-procedural language for defining, creating, maintaining, updating and querying a relational data base, which is viewed as a collection of time-varying relations of assorted degrees. The generalized set theoretical operators for manipulating hierarchical relations are discussed. Language statements refer only to the user's logical data representation and are independent of underlying data base management system technology.

Braden, R., "Interim NETRJS Specifications", RFC 189, NIC 7133, July 1971.
[Data Transfer, Protocol, NETRJS]

This document describes the operation and protocol of the remote job entry service to CCN's 360 model 91. The interim protocol described will be implemented as a production service and it will be superseded in a few months by a revised NETRJS which would bring the data transfer protocol of NETRJS into complete conformity with the proposed Data Transfer Protocol (DTP).

Bressler, R., "Interprocess Communication on the ARPA Computer Network", MIT Civil Engineering MS Thesis, June 1971.
[Inter-process Communication, Co-operating Processes, Resource Sharing, Time Sharing, IMP, NCP, Socket, Flow Control, ARPANET]

The development of a Network Control Program (NCP) for the ITS PDP-10 timesharing system is outlined. The relationship between the I/O structure of a time sharing system and the network as an I/O device is defined. Finally, the control commands and the choice of sockets as the mapping device for the link space is examined and suggestions for improvement in the NCP are given.

Bressler, R., "Free File Transfer", RFC 487, Apr. 1973.
[Access Control, Accounting, FTP, Security]

This RFC discusses briefly an access control and accounting problem inherent in a network where each host does its own user validation. Also see RFC's 501 and 505.

Bressler, R., Guida, R., McKenzie, A., "Remote Job Entry Protocol", RFC 407, Oct. 1972.
[Protocol, FTP, RJE, NETRJS]

This document defines the present ARPANET RJE protocol. The document is slightly inaccurate in that it has not been revised to conform to the newer FTP (see RFC's 542 and 460) and is based on the older FTP described in RFC 354. This protocol provides a good example of what a network RJE facility should provide.

Bressler, R., Murphy, D., Walden, D., "A Proposed Experiment with a Message Switching Protocol", RFC 333, NIC 9926, May 1972.
[Message Switched Protocol, Protocol, Communications, Host-Host Protocol, NCP]

A message switching protocol (MSP) is a system whose function is to switch messages among its ports. The authors propose, as an aside to network development using the current NCPs, to rethink the design of NCP-level software beginning with a consideration of MSPs. The organization of the lowest level host-host protocol in the ARPA Network around MSPs, and how this organization would affect the implementation of host software, is described.

Bressler, R., Thomas, R., "Inter-Entity Communication--An Experiment", RFC 441, Jan. 1973.
[Resource Sharing, User Support]

This paper describes highly successful early attempts on the ARPANET to develop techniques of user-user communication. The experiment allowed a user to "find" another user if he was on any other machine on the network participating in the experiment. He was also able to talk to the user, show the user what he was doing, etc. The experiment was performed between the PDP-10 at MIT-DMCG and the various PDP-10 TENEX systems.

British Post Office, "Experimental Packet Switched Service", Issue 3, January 1974.
[Packet Communication, Protocol, Distributed System, EPSS]

A detailed specification of the British Post Office experimental packet switched data communication service is given.

Browne, P., Steinauer, D., "A Model for Access Control", ACM SIGFIDET Workshop on Data Description, Access and Control, 1971, pp. 241-262.
[Access Control, Resource Sharing, Authorization, Protection]

The problems of authorization for a multiple-user resource sharing data processing system are discussed. The requirements for the access of objects (e.g., terminals, users, programs, etc.) to other objects are covered in some detail. A model for access control is developed which combines the military-type level (tree-structured) classification and a category or clique classification. No discussion is given of efficiency, issues of identification, or other advantages and disadvantages of the model.

Bryan, G.E., Shemer, J.E., "The UTS Time-Sharing System: Performance and Evaluation", Proc. Second Symposium on Operating System Principles, Princeton, 1969, pp. 147-158.
[Measurement, Performance Evaluation]

The paper develops a set of statistics that can be used in conjunction with a mathematical model to allow dynamic tuning of the system. The model itself is based on a cyclic queue arranement.

Buchholz, W., "A Synthetic Job for Measuring System Performance", IBM Sys. Journal 8, No. 4, 1969, pp. 309-318.
[Measurement, Performance Evaluation, Synthetic Jobs]

This paper describes the advantages and disadvantages of synthetic benchmarks versus traditional benchmarks. A parameterized synthetic program is developed that effectively exercises both I/O and computational functions.

Burroughs Corp., "Work Flow Language User's Manual", Burroughs Corp., 1973.
[Command Language, User Support]

This document describes the implementation of a job control language. WFL designers have done many things correctly in providing a clear, easy to use ALGOL-like language that should be inspected by any designer of a job stream language.

Buzen, J., "Analysis of System Bottlenecks Using a Queueing Network Model", SIGOPS Workshop on System Performance Evaluation, ACM, April 1971, pp. 82-103.
[System Performance, Queueing Theory, Traffic Analysis]

A model of a single control processor and multiple I/O processors is studied (central server model). All services are assumed exponential and the number of customers is a constant, N, corresponding to the number of partitions in the system. Steady-state probabilities of utilization of each processor are obtained as well as queue lengths. System performance is evaluated and bottlenecks defined.

Cady, G.M., "Computation and Communication Trade-off Studies: An Analytical Model of Computer Networks", Proc. WESCON Conf., 1972, pp. 1-12.
[Measurement, Performance Evaluation, Queueing Theory, Simulation]

The author develops a comprehensive model of a computer network combining the attributes of the hosts and the communications subnet. The article primarily discusses the assumptions and theory on which the model is built.

Calvin, J.O., "The Design and Implementation of an Interactive Teleconferencing Environment", Undergraduate Thesis, Case Western Reserve Univ., May 1974.
[Teleconferencing, ARPANET]

This paper describes the design and implementation of a network teleconferencing protocol and server for the ARPANET. The protocol and its implementation (for the PDP-10 Tenex) constitutes one of the most sophisticated teleconferencing systems developed to date.

Campbell D.J., Heffner W., "Measurement and Analysis of Large Operating Systems during System Development", AFIPS FJCC, 1968, pp. 903-914.
[Measurement, Performance Evaluation]

The article describes the kind of measurements that are part of the GCOS III System. The approach taken is basically heuristic. The article discusses the parameters measured and the experience gained, but makes no attempt to draw any general conclusions from the measurements. It appears that the analysis is as heuristic as the choice of measures. The primary value of this paper is that it presents a good view of the rather rich abilities to measure the GCOS system.

Cantor, D.G., Gerla, M., "The Optimal Routing of Messages in a Computer Network via Mathematical Programming", Proc. IEEE COMPCON72, 1972, pp. 167-170.
[Routing]

The problem of finding the optimal routes for messages in a message-switched computer network is treated as a non-linear multicommodity flow problem. An exact solution is produced by this scheme which is not susceptible to limitations imposed by heuristic schemes.

Cardenas, A.F., "Evaluation and Selection of File Organization--A Model and System", CACM 16, 1973, pp. 540-548.
[Data Structuring, Data Accessing]

This paper briefly discusses a simulation system for estimating storage costs and average retrieval times, given parameters characterizing the data base, query complexity, and the storage device. A number of test results on real data bases are summarized. Structures compared were of the inverted file, multilist, and doubly-chained tree types.

Casey, R.G., "Allocation of Copies of a File in an Information Network", AFIPS Conference Proceedings 40, 1972, pp. 617-625.
[File Allocation]

A model is set up to assign a file to network nodes based on minimizing the total update/query/storage costs. The number of file copies is a variable. An efficient search procedure is developed to find the true minimum, and heuristics for "good" solutions are discussed.

Casey, R.G., "Design of Tree Networks for Distributed Data", AFIPS Conference Proceedings 42, 1973, pp. 251-257.
[File Allocation, Network Topology]

This paper combines techniques for network design and Casey's file allocation algorithm (Casey, 1972) into a single algorithm for design of the network and allocation of the files, when information on data bases and their usage is known in advance.

Casey, R.G., "Design of Tree Structures for Efficient Querying", CACM 16, 1973, pp. 549-556.
[Data Structuring, Data Partitioning, Data Trees, Search Trees, Data Clustering]

An algorithm for designing a near-optimal tree structure for data is given. Optimality is defined in terms of total minimum search-path length for a given set of queries. Some pre-clustering of the data (using information on which records are retrieved together) is suggested to make the approach more practical for large files.

Cerf, V., "The Current Flow-Control Scheme for IMPSYS", RFC 442, NIC 13774, Jan. 1973.
[IMP, Flow Control, Communications Subsystem, ARPANET, Traffic Control]

The ARPANET IMP flow control as of Jan 1973 is presented in an understandable form. The control was intended to eliminate unnecessary retransmissions of packets when the net is under heavy load and to increase net bandwidth. The strategy involves multiple acknowledgements piggy-backed onto data packets between two IMPS.

Cerf, V., "An Assessment of ARPANET Protocols", RFC 635, Apr. 1974.
[IMP-IMP Protocol, Host-Host Protocol, Network Performance]

This paper discusses some of the theoretical and practial aspects of the ARPA IMP-IMP and Host-Host protocols. Of major importance are problems such as packet re-assembly, retransmission, and duplicate detection. The author makes recommendations for new protocols based on past experience.

Cerf, V., Dalal, Y., Sunshine, C., "Specification of Internet Transmission Control Program", Inter Network Working Group Paper #72, 1974.
[Host-Host Protocol, IPC, Flow Control]

This paper provides a detailed description of the Internet protocol and the control program necessary to implement it. The paper covers the problems of reconnection, flow control, and measurement in the environment of the new protocol. The document is a guide to implementers of the protocol.

Cerf, V., Kahn, R., "Host and Process Level Protocols for Internetwork Communication", Inter Network Working Group Draft Report, July 1973.
[Host-Host Protocol, Flow Control, Reliability]

This paper describes the inter-network protocol developed by the inter-network working group. The protocol provides clean handling of process-process communication and flow control. It can best be described as a hybrid message-switch protocol.

Cerf, V., Naylor, W., "Selected ARPA Network Measurement Experiments", Proc. IEEE COMPCON72, 1972, pp. 201-204.
[ARPANET, Routing, Flow Control]

This paper analyzes the cost of multipacket message re-assembly in the ARPANET IMP. This paper represents an argument for the reservation of the correct number of re-assembly buffers in the destination IMP.

Chai, D.T., "Language Considerations for Information Management Systems", Proc. ACM, 1974, pp. 443-450.
[Natural Language]

Arguments against using English as the query language for information management systems are preseted. The difficult problem is determining the intended meaning of the request.

Chamberlin, D.D., Boyce, R.F., "SEQUEL: A Structured English Query Language", IBM Research Report RJ 1394, 1974.
[Relational Query Language]

A structured English query language for accessing a relational data base is presented. Queries are formulated as set-oriented table look-ups rather than selecting a row at a time.

Chambers, J.M., "A User-controlled Synchronization Method", IBM SIGOPS, 1974, pp. 16-25.
[Deadlock Prevention, Process Synchronization]

This paper discusses a method of inter-process communication by which processes can request resources, find out whether those resources have been received, and detect deadlock without ever necessaily being blocked. This allows the processes to possibly take alternative actions when the requested resources are not currently available.

Chandler, A., Adams, C., Barry, P., Dewis, I., Hammond, N., Higginson, P., John, R., Olejniczak, J., "Report of the Higher Level Protocol Working Group", InterNetwork Working Group Protocols Note #6, Aug. 6, 1974.
[Protocol, EPSS, Interactive Terminal Protocol, FTP, RJE, Data Transfer Protocol]

Specifications are given for four high level protocols--Interactive Terminal Protocol (ITP), File Transfer Protocol (FTP), Remote Job Entry Protocol (RJE), and Data Transfer Protocol (DTP)--for the Experimental Packet Switched Service (EPSS).

Chandra, A.N., "Some Considerations in the Design of Homogeneous Distributed Data Bases", Proc. IEEE COMPCON73, 1973, pp. 185-186.
[Distributed System, Data Management Overview]

This paper briefly discusses many of the problems associated with the design of a distributed data base which is to reside on a homogeneous network.

Chen, P.P.S., "Optimal File Allocation in Multi-level Storage Systems", AFIPS Conference Proceedings 42, 1973, pp. 277-283.
[File Allocation]

A model for a multi-level storage system (for a central processor) is set up and several optimization problems (e.g. minimization of total storage cost with a mean response time constraint) are discussed. Inclusion of queueing delays make the model more realistic than that of earlier analyses. Algorithms are included.

Chen, P.P.S., Mealy, G.H., "Optimal Allocation of Files with Individual Response Time Requirements", Proc. Seventh Annual Princeton Conf. on Information Sciences and Systems, pp.1-4.
[File Allocation]

This work is similar to that reported in Chen (1973), except that different response time constraints may be assigned to individual files. A branch-and-bound algorithm is proposed.

Chesson, G.L., "Communication and Control in a Cluster Network", Proceedings ACM, 1974, pp. 509-514.
[Interprocess Communication]

A communications scheme for an interconnected network of processors typified by short-delay communications, local memory, and software controlled scheduling, resource allocation, and interprocess communication, is described. The scheme permits a program to use all the available multiprocessing power it needs while yielding the same results if operated with one processor.

Chien, R.T., Mark, E.A., "A Document Storage Method Based on Polarized Distance", JACM 21, 1974, pp. 233-245.
[File Allocation, Clustering, Retrieval Strategies]

Documents are clustered according to "weight" or number of non-zero terms in their binary index vectors. Theorems are developed to determine which clusters should be searched for a given query. A brief analysis compares the method with linear and inverted filing schemes.

Childs, D.L., "Feasibility of a Set-Theoretic Data Structure", IFIP Congress 68, 1968, pp. 420-430.
[Set Theoretic Data Structures]

Many problems dealing with arbitrarily related data can be expedited on a digital computer by a storage structure which allows rapid execution of operations within and between sets of datum names. The structure should be general enough that the sets involved may be unrestricted, and the set of operations should be general in nature. These problems are resolved in this paper by the introduction of the "complex" concept which also allows natural extension of properties of binary relations to properties of general relations.

Childs, D.L., "Description of a Set-Theoretic Data Structure", AFIPS FJCC, 1968, pp. 557-564.
[Set Theoretic Data Structures]

Data which are not intrinsically related have to be expressed (stored) in such a way as to define the way in which they are related before any data structure is applicable. Since any relation can be expressed in set theory as a set of ordered pairs, and since set theory provides a wealth of operations for dealing with relations, a set-theoretic data structure appears reasonable.

Chu, W.W., "File Allocation in a Multiple Computer System", IEEE Trans. Computers C-18, Oct. 1969, pp. 885-889.
[File Allocation]

A model is set up and the author shows how an optimal file allocation may be obtained as the solution to a linear integer (zero-one) programming problem. The zero-one variables to be determined indicate whether or not a given file resides in a given processor. Use of the approach seems limited to situations where the number of processors and the number of files are small.

Chu, W.W., "Optimal File Allocation in a Computer Network", Computer Communications Networks, N. Abramson and F. Kuo, eds., Prentice Hall, 1973, pp. 82-94.
[File Allocation]

The technique here is basically the same as in Chu (1969), but the model is extended to include redundant file copies in order to achieve a prescribed level of file availability.

Chu, W.W., Ohlmacher, G., "Avoiding Deadlock in Distributed Data Bases", Proc. ACM, 1974, pp. 156-160.
[Access Control, Data Base Integrity, Deadlock Prevention, Distributed System]

This paper discusses three methods of deadlock prevention or detection based on availability of prior knowledge of file use by a process, and whether files are pre- or demand-allocated. Ways of implementing all three techniques on a distributed network are presented.

Cocanower, A., "MERIT Computer System: Software Considerations", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 65-77.
[Traffic Control, MERIT, Process Synchronization, Inter-process Communication, Communications Processor, Front End Processor, Multi-tasking, Semaphores]

The programming considerations for the MERIT Computer Network are described briefly with respect to host and communication computer philosophy, organization, component description and function, operating system design, and traffic regulation. Implementation difficulties and potential user problems are discussed.

CODASYL, "An Information Algebra", CACM 4, April 1962, pp. 190-204.
[Data Languages]

This report represents the results of the first phase of the work of the Language Structure Group. The goal of this work is to arrive at a proper structure for a machine-independent problem-defining language at the systems level of data processing. The report is based on the mathematical model "An Information Algebra", developed primarily by R. Bosak. A philosophy for the professional people who are vitally concerned with providing a working language for the systems analyst's use is presented.

CODASYL Data Base Task Group, "April 1971 Report", ACM, New York City, April 1971.
[Data Description Language, Data Manipulation Language]

The DBTG is concerned with the sharing of data management by multiple applications. It proposes a technique for superimposing a view (sub-schema) on the data base and a language to manipulate the data.

Codd, E.F., "A Relational Model of Data for Large Shared Data Banks", CACM 13, June 1970, pp. 377-387.
[Relational Theory]

The author proposes the relational model of data for use in data banks. It is hoped that this model will provide a simple and complete view of data usable by a large community of users.

Codd, E.F., "Further Normalization of the Data Base Relational Model", Data Base Sysems, R. Rustin, ed., Prentice-Hall, 1972, pp. 125-141.
[Relational Theory]

Simplifications are proposed for the relational model which will remove certain update anomalies and provide a more consistent view.

Codd, E.F., "Normalized Data Base Structure: A Brief Tutorial", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 1-17.
[Relational Structures]

This tutorial discusses the relational view of data and techniques to simplify data base relations by normalization.

Codd, E.F., "A Database Sublanguage Founded on the Relational Calculus", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 35-68.
[Query Languages]

The author describes ALPHA, a data base sublanguage founded on the relational calculus, and compares it with other data base sublanguages.

Codd, E.F., "Seven Steps to Rendezvous with the Casual User", Proc. IFIP TC-2 Working Conference on Data Base Management Systems, 1974.
[Query Languages, Relational Theory]

The underlying concepts of a natural English query language are described. It is assumed that the user will not correctly state his query on his first attempt and it is the responsibility of the system to help him rephrase the query.

Codd, E.F., "Recent Investigations in Relational Data Base Systems", IBM Research Report RJ 1385, April 1974.
[Relational Theory]

An overview of the relational approach to data management is presented. Included in the overview are recent advances in relational theory, and areas which require investigation.

Codd, E.F., "Relational Completeness of a Data Sublanguage", Data Base Systems, R. Rustin, ed., Prentice-Hall, 1972, pp. 65-98.
[Query Languages]

A relational algebra which operates on Codd's model of a relational data base is defined and shown to be complete. A relational calculus is defined and an algorithm is given to map the calculus onto the algebra. The calculus and algebra are compared in terms of ease of augmentation, search optimization, authorization capability, and closeness to natural language.

Coffman, E.G.,Jr., Eve, J., "File Structures Using Hashing Functions", CACM 13, 1970, pp. 427-432, 436.
[Data Structures, Data Trees]

This paper suggests that keys be transformed through a hashing function into binary strings, following which the strings may be used in the usual ways to generate binary-tree structured data.

Cole, G., "Computer Network Measurements: Techniques and Experiments", UCLA-ENG-7165, UCLA, October 1971.
[Measurement, Traffic Analysis, Modeling]

The development of a measurement capability and the utilization of this capability to create (and iteratively improve) analytic models of network behavior as well as true system parameters is discussed.

Collier, W.W., "Asynchronous Interactions on Shared Data", IBM SIGOPS, 1974.
[Deadlock Prevention, Process Synchronization]

If the hardware on which a program is to be run has uninterruptable instructions for manipulating the memory referenced by two processes, then those processes can be written so that they can both reference memory without hindering each other.

Collmeyer, A., Sherner, J., "Analysis of Retrieval Performance for Selected File Organization Techniques", AFIPS 37, pp. 201-210.
[Retrieval Strategies, Data Structures]

Models for three basic types of indexing--spatial, tabular, and calculated-- are developed and analyzed.

Computer Communications Group, "Datapac Standard Network Access Protocol", Trans-Canada Telephone System, Nov. 1974.
[Host-Host Protocol, Imp-Host Protocol, Datapac]

This paper discusses in detail the characteristics of the node to host and host to host protocols in the Bell Canada Datapac network.

Constant, M.L., Seeley, P.L., "Computer-Mediated Human Communications in an Air Traffic Control Environment: A Preliminary Design", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[Teleconferencing]

The air traffic controller is required to be not only a manager and decision maker but also a data processor, manipulator, and recorder in addition to a data transmission device. This paper discusses the use of the computer to relieve the load on the controller.

Cotton, I., "Network Management Survey", Seventh Hawaii International Conference on System Sciences - Subconference on Computer Networks, 1974.
[Network Management, ARPANET, MERIT, TYMNET]

A brief comparison in table format is presented of management practices for the ARPANET, MERIT, TUCC, Oregon State, and Tymnet networks. All information is from reference material.

Coulouris, G., Evans, J., Mitchell, R., "Toward Content Addressing in Data Bases", Comp. J. 15, May 1972, pp. 95-98.
[Content Addressing]

A data base is required to hold two classes of information: values, and relations between values. A "content addressed" system in which records are specified by the properties of the data items they contain is proposed. The characteristics and performance of existing data base management systems are discussed and evaluated, and some benefits to be expected from hardware-aided content-addressing systems are identified. An approach to the design of a hardware-aided content-addressed file system is proposed.

Crocker, D., "Proposed Network Virtual Pathname", RFC 615, 1974.
[FTP, ARPANET]

This is a preliminary definition of a syntax for a network-wide pathname for files on the ARPANET. The paper presents no discussion and is meant to elicit discussion amongst designers. The paper has been replaced by RFC 645.

Crocker, D., Day, J., Hill, A., Kudlick, M., "Considerations in Defining and Evaluating a Network Service", USING Note available through NIC, Jan. 1974.
[User Support]

This paper was prepared for USING as a guideline for servers and the quality of service. Points addressed are system stability, availability, reliability, documentation, file system maintenance, etc.

Crocker, D., Neiger, N., Feinler, J., Iseli, J., "ARPANET Users Interest Group Meeting", RFC 585, Nov. 1973.
[User Support]

This RFC reports the first meeting of USING and the problems it set about to address. These problems, e.g., documentation and consulting, user standard interfaces, user feedback mechanisms, accounting, etc., are highly relevant to any heterogeneous network.

Crocker, D., Postel, J., "Thoughts on the Mail Protocol Proposed in RFC 524", RFC 539, July 1973.
[Mail, User Support]

This RFC is one of the critiques of White's Mail Protocol. The paper makes several points, some of a minor nature, on the protocol produced by White, and suggests improvements.

Crocker, S., Heafner, J., Metcalfe, R., Postel, J., "Function-oriented Protocols for the ARPA Computer Network", AFIPS SJCC, 1972, pp. 271-279.
[ARPANET, Protocol, Interprocess Communication]

A brief description is given of low level protocols which make up the communications subnet of the ARPANET. The use of remote interactive systems through high level function-oriented protocols--such as FTP, TELNET, and RJE--is discussed.

Crouch, D.B., "A Process for Reducing Cluster Representations and Retrieval Costs", Proc. ACM 1973, pp. 224-227.
[Data Clustering, Retrieval Strategies]

This is another paper on the technique of clustering documents for retrieval by cluster representative. (cf. Jardine and van Rijsbergen, 1971). This paper addresses the problem of compressng the cluster "representatives" in order to reduce storage and search costs. The author claims effective retrieval after ninety per cent compression.

Crowther, W., Heart, F., McKenzie, A., McQuillan, J., Walden, D., "Report on Network Design Issues", InterNetwork Working Group Note #64, Oct. 31, 1974.
[Flow Control, Store and Forward Networks, Network Interconnection, Network Design, Packet Communication, ARPANET, Deadlock]

Packet switching design issues--design requirements; message processing by the subnet; single packet messages only; packet size; lock-ups; interreference; and other bugs and short comings--are discussed, especially as they relate to the ARPA Network.

Currey, J.E., "Tablet Handling in an Interactive Graphics Environment", Computer Display Review, Keydata Corp., Watertown, Mass.
[Graphics, Man-machine Communication]

A "user-trainable" tablet input system is described. An example of a circuit design session using user-defined input symbols for entering and editing components is given.

Daley, R., Dennis, J., "Virtual Memory, Processes, and Sharing in MULTICS", CACM 11, May 1968, pp. 306-312.
[MULTICS, Virtual Memory, Data Sharing, Dynamic Linking, Multi-programming, Storage Management, Storage Hierarchies, Resource Sharing, Security]

Basic concepts involved in the design of the MULTICS operating system, such as processes, address space, and virtual memory, are introduced and defined. Procedure and data sharing is discussed and the dynamic transformation of symbolic references into virtual machine addresses is described in detail.

Date, C., Hopewell, P., "Storage Structure and Physical Data Independence", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 139-168.
[Relational Data Structures]

The results of an investigation into the feasibility of physical data independence in a data base system are presented. The question, "Given a third normal form data picture, to what extent may the storage structure change?", is answered by first defining and explaining a number of concepts and using these concepts to illustrate some possible storage structures for a sample data base.

Date, C.J., Hopewell, P., "File Definition and Logical Data Independence", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 117-138.
[Data Independence]

An interface between applications program and data base which provides for logical and physical data independence is described. The minimum requirements for a language that manipulates this interface are given.

Davidson, J., "An Echoing Strategy for Satellite Links", RFC 357, NIC 10599, June, 1972.
[Satellite Communication, Telnet Protocol]

This document is a description of a technique for reducing the apparent echoing delay experienced by terminal users when the echoing is being performed over a long-delay, e.g., satellite path. These ideas were essentially implemented in the second version of the ARPANET TELNET protocol (Remote Controlled Transmission and Echoing Option).

Davies, D., "The Principles of a Data Communication Network for Computers and Remote Peripherals", IFIPS 68, North Holland Pub Co., 1969, pp. 709-715.
[Store and Forward Networks, Packet Communication]

An outline for a store-and-forward common-carrier data network is proposed.

Davies, D., Bartlett, K., Scantlebury, R., Wilkinson, P., "A Digital Communication Network for Computers Giving Rapid Response at Remote Terminals", ACM Symposium on Operating System Principles, October 1967.
[Store and Forward Neworks, Common Carrier Data Network, Network Design, Packet Communication, Time Sharing]

A design for a common-carrier data network is described. Topics include link design, node design, message transmission, software organization, network performance estimates and node performance estimates.

Davies, D.W., Barber, D.L.A., "Communication Networks for Computers", John Wiley and Sons, 1973.
[ARPANET, Communications, Error Detection, Error Recovery, Flow Control, Network Bandwidth, Network Design, Packet Communication Analysis, Routing]

A comprehensive text dealing with most aspects of computer networks from the basic communications hardware up to network software. The detail is severe on some data communications techniques.

Dean, A.,Jr., "Data Privacy and Integrity Requirements for On-line Data Management Systems", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 279-298. [Data Security, Data Integrity]

This paper identifies the data privacy and integrity capabilities required by an online data management system. The overall operation of an online data management system, the hardware, operating software, and application software of an online data management system are described in terms of the data privacy and integrity capabilities to be supplied by each of these parts of a system.

Dearnley, P., "A Model of a Self-Organizing Data Management System", Comp. J. 17, Jan. 1974, pp. 13-16. [Data Structuring, Data Reconfiguration, Automatic Data Structuring]

This follows up on the ideas in Stocker and Dearnley (1973), giving some details on implementation and reporting on an actual test.

Dearnley, P.A., "The Operation of a Model Self-Organizing Data Management System", Computer J. 17, 1974, pp. 205-210. [Data Structuring, Data Reconfiguration, Automatic Data Structuring]

This paper, a continuation of earlier work, reports on more extensive trials of the system, including cost analyses.

Defiore, C., Berra, P., "A Data Management System Utilizing an Associative Memory", AFIPS 42, 1973, pp. 181-187. [Cotent Addressing]

The utilization of an associative schemata for solving data management problems is described. Advantages include few superimposed additional structures for machine representation and the need for indexing is eliminated. No directories are required so overhead is kept at a minimum and updating can be accomplished as rapidly as queries. The major disadvatage is the cost of the hardware as a result of more complex logic.

DeFiore, C.R., Stillman, N.J., Berra, P., "Associative Techniques in the Solution of Data Management Problems", Proc. ACM, 1971, pp. 28-36.
[Relational Data System, Content Addressing]

This paper is concerned with the development of data management systems from an associative point of view. The design utilizes relational set theory applied to information systems. The basic notion involves the mathematical transformation of hierarchical structures of n-ary relations into associative normal form (ANF). This transformation preserves the information content while at the same time allowing the information to be manipulated by an associative memory in a more efficient manner than is possible on a random access memory.

Denning, P.J., "A Statistical Model for Console Behavior in Multi-user Computers", CACM 11, 1968, pp. 605-612.
[Measurement, Performance Evaluation, Statistics, Queueing Theory]

This paper develops a highly useful model for console behavior that answers questions relevant to the number of blocked processes, buffer requirements, rate processes can execute, etc.

Denning, P.J., Eisenstein, B.A., "Statistical Methods in Performance Evaluation", Proc. ACM Workshop on System Performance Evalation, 1971, pp. 284-307.
[Measurement, Performance Evaluation, Statistics]

This paper applies the principles of estimation theory to the development of a theory for oerformance evaluation and resource allocation. The statistical characterization is discussed with reference to bias, convergence, and responsiveness of the parameter.

Dennis, J.B., "On the Exchange of Data", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1970, pp. 41-66.
[Data Definition Language, Data Structures]

This paper addresses the problem of moving data between computer installations, which may differ in their hardware, software, or program libraries and data files.

Desautels, E., Chow, V., Schneider, M., "Loosely Coupled Systems", Computer Sciences Technical Report #187, University of Wisconsin at Madison, July 1973.
[Front-end Processor, Time Sharing, Intelligent Terminal]

An outline is given of a current investigation into costs and benefits of coupling a small time sharing system to a large multi-programmed system. Directions of research include the use of the small system as an "intelligent" terminal or a front-end processor.

Despres, P., Guinaudeau, P., "RCP--The Experimental Packet-Switched Data Transmission Service of the French PTT", Inter Network Working Group General Note #67, Aug. 1974.
[Packet Communication, Store and Forward Networks, Virtual Memory Flow Control]

An experimental packet-switched data transmission network, based on the use of virtual circuits, is described. Detailed information is given on the network hardware configuration, network commands, and protocols for virtual circuit switching.

Deutsch, P.L., "Cross-country Network Bandwidth", RFC 567, NIC 18970, Sept. 1973.
[ARPANET, Traffic Analysis, Network Bandwidth]

This paper presents a very brief analysis attributing network peak loads to the undue delays in the cross country echoing of characters over ARPANET.

Dijkstra, E.W., "Hierarchical Ordering of Sequential Processes", Acta Informatica 1, Springer-Verlag, 1971, pp. 115-138.
[Multi-programming, Process Synchronization, Interprocess Communication]

This paper introduces the concept of "layered" design of operating systems. It then discusses the semaphore, a mechanism used by "virtual machines" or processes to guarantee mutual exclusion from critical sections and effect synchronization of "consumers" and "producers" of a consumable resource. A problem of mutual exclusion called the "five dining philosophers" is discussed and a solution proposed.

Dijkstra, E.W., "A Class of Allocation Strategies Inducing Bounded Delays Only", AFIPS SJCC, 1972.
[Resource Sharing, Multi-programming, Process Synchronization]

A set of conditions and an allocation strategy are presented that prevent starvation in any of a set of processes competing for a set of resources.

Dijkstra, E.W., "Co-operating Sequential Processes", Programming Languages, F. Genuys, ed., Academic Press, New York 1968.
[Resource Sharing, Multi-programming, Process Synchronization, Interprocess Communication, Semaphore]

This paper describes the general problems encountered by co-operating sequential processes and some specific solutions. A set of primitives to effect co-ordination between co-operating sequential processes is motivated and developed. These primitives, the P and V operations on an object called a semaphore, are discussed in detail with examples. Co-operation using status variables, with semaphores providing mutual exclusion, to permit more arbitrary co-ordination than semaphores allow is also described. Finally, the banker's algorithm, a deadlock prevention scheme, is motivated and described.

Dodd, G., "Elements of Data Management Systems", Computer Surveys, June 1969.
[Data Management Overview]

A description is given of the basic types of data management techniques, as well as the relation of each to the hardware on which it is used. Then it is shown how these basic elements can be used as building blocks to describe and build more complex data management systems. Finally, there is a discussion of languages used for programming data management systems.

Dostert, B.H., Thompson, F.B., "How Features Resolve Syntactic Ambiguity", Proc. Symposium on Information Storage and Retrieval, ACM, 1971, pp. 19-32.
[Natural Language]

Techniques for resolving ambiguities in natural language using the context of the ambiguity are discussed.

Earley, J., "Toward an Understanding of Data Structures", CACM 14, 1971, pp. 617-627.
[Data Structures, Access Paths]

This paper describes a formalism for describing both data structures and their implementation, in the sense that access paths are explicitly represented in the formalism. The work is preliminary; an elaborate mathematical construct is only hinted at and many problems for further study are given.

Earley, J., "On the Semantics of Data Structures", Data Base Systems, R. Rustin, ed., Prentice-Hall, 1972, pp. 23-32.
[Data Languages]

Some ideas about what properties a language should have in order to deal with data structures is presented. There are three levels of description of data structures which should be handled: 1) the implementation (machine) level, 2) a logical (semantic) level in which access paths are specified explicitly, and 3) a logical level in which only the relationships between data items are specified.

Elias, P., "Efficient Storage and Retrieval by Content and Address of Static Files", JACM 21, 1974, pp. 246-260.
[Retrieval Strategies]

This is a highly theoretical paper dealing with a file of fixed-length binary words and simple query types. Lower bounds on measures of bits stored and bits accessed per query are given and algorithms approaching those bounds are presented.

Ellis, M.E., Nelson, K.H., "A Data Description Language for Hierarchical Data Files", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1970, pp. 87-106.
[Data Description Language]

The paper begins with a discussion of the objectives and restrictions of the language, continues with a complete language description, and concludes with remarks on the language processor and extensions to the language.

Engles, R.W., "A Tutorial on Data Base Organization", Annual Review in Automatic Programming, Vol. 7 Part 1, 1972, pp. 1-64.
[File System Design, Data Independence, Data Structuring]

The first section of the report is an introduction, which includes data management history, trends, and terminology; the second section presents a theory of operational data based on the notions of entity sets and data maps; the third section is an exposition of data base design, emphasizing structure, search, and maintenance; the fourth section shows why data independence is a necessary feature of a viable data base system.

Engles, R.W., "An Analysis of the April 1971 Data Base Task Group Report", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 69-91.
[Data Structures, Data Definition Language, Data Manipulation Language]

The strengths and weaknesses of the DBTG report are discussed. Suggestions are then presented for some of its problems.

Estrin, G., Kleinrock L., "Models and Measurements for Time-shared Computer Utilities.", Proc. Conf. ACM, 1967, pp. 85-96.
[Measurement, Performance Evaluation, Queueing Theory]

This paper is a very good survey of the predicted characteristics of queueing theory models of time sharing systems and the results of several measurement projects of such systems. The validity of the models with respect to the measurements is discussed..

Fabry, R.S., "Dynamic Verification of Operating System Decisions", CACM 16, Nov. 1973, p. 659.
[Operating System, Data Security, Error Detection, Protection]

A description of Berkeley's PRIME system is given. Protection against "leakage" of data due to operating system failure is provided by software-firmware redundancy. Key decisions (e.g., process creation, page allocate/deallocate, messages) made by software must go through, and be verified by, the firmware.

Farber, D., "Networks: An Introduction", Datamation 18, April 1972, pp. 36-40.
[Network]

This article gives an overview of this expanding field by examining seven typical networks: ARPA, CYBERNET, DCS, MERIT, OCTOPUS, TSS, and TVCC.

Farber, D., "Data Ring Oriented Computer Networks", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 73-93.
[Distributed System, DCS, Error Detection, Error Correction, Process Synchronization, Ring Network]

A general discussion of broadband communications systems, with a detailed discussion of a particular distributed system known as a data ring, is presented in the context of its application to computer networks. The functional advantages as well as the technical difficulties in the implementation and use of the data ring are discussed. (author abstract)

Farber, D., Larson, K., "The System Architecture of the Distributed Computer System--The Communications System", Computer Communications Networks & Teletraffic, J. Fox, ed., 1972, pp. 21-27.
[DCS, Distributed System Technology, Broadcast Mode, Protocol, Error Detection, Error Correction, Ring Network]

The Distributed Computer System (DCS) is a data communications ring. The communications protocols are described and the advantages are given for addressing mesages to processes, removing a message from the ring only at the originating Ring Interface, and message sequencing. Error detection and correction are also discussed.

Farber, D., Larson, K., "The Structure of a Distributed Computing System--Software", Computer Communications Networks and Teletraffic, J. Fox, ed., 1972, pp. 539-545.
[DCS, Ring Network, Protocol, Distributed Network Technology, Inter-process Communication, Process Synchronization, Ring Protocols]

A general description of the design goals and hardware topology of the Distributed Computing System (DCS) is given. It is shown how they shaped the operating system. A description is given of the level structure of the operating system. Future plans for the network are presented.

Farber, D.J., "The Structure of a Distributed Computer System--The Distributed File System", First Int'l Conf. on Computer Communications, Oct. 1972, pp. 364-370.
[Distributed System, File System Design, Network, DCS]

The DCS is a distributed computer system in which resource allocation is handled by the processes bartering with one another directly rather than through a central processor. This paper discusses the file system on the DCS, which has properties such that losing any processor does not affect any files not stored on that processor, and moving a file from one processor to another in no way affects the user's view of how to access the file.

Fehder, P.L., "The Representation-Independent Lanuage, Part 1: Introduction and Subsetting Operation", IBM Research Report RJ 1121, 1972.
[Query Languages]

RIL, a query language for specifying transactions in the context of an entity-set-structured data base, is described. Boolean expressions and temporary variables are used to subset entity sets.

Feldman, J.A., Rovner, P.D., "An Algol-Based Associative Language", CACM 12, Aug. 1969, pp. 439-449.
[Content Addressing]

A language in which items are addressed by partial content instead of address is described. Until associative memories become economically feasible, the data structures are implemented using hashing techniques.

Finkel, R.A., Bentley, J.L., "Quad Trees: A Data Structure for Retrieval on Composite Keys", Acta Informatica 3, 1974, pp. 1-9.
[Data Structures, Retrieval Strategies]

Data are often structured into a binary tree on the basis of the ordered values of one key. A "quad tree" is an analogous structure based on the values of two keys.

Fletcher, J., "OCTOPUS Communications Structure", Seventh Annual IEEE Computer Society International Conference (COMPCON 73), 1972, pp. 21-23.
[OCTOPUS, Message Transmission, File Transfer]

A general description is given of the OCTOPUS compter network and its underlying subnetwork structure. Message transmission and file transfer as a means of communication over the subnets are briefly discussed.

Florentin, J.J., "Consistency Auditing of Databases", Computer Journal 17, Jan. 1974, pp. 52-58.
[Data Base Integrity]

This paper discusses an approach for checking the consistency of the information in a data base, by requiring that every transaction be allowed to happen only if it will not cause the data to violate specified mathematical rules.

Foley, J., Brownlee, E., "A Model of Distributed Processing in Computer Networks with Application to Satellite Graphics", Paper submitted to IFIP Congress, 1974.
[Distributed Computing, Graphics, Time Sharing, Resource Allocation, Modeling]

An optimization model of distributed processing in computer networks is developed with respect to response time.

Fralick, S.C., Brandin, D.H., Kuo, F.F., Harrison, C., "Digital Terminals for Packet Broadcasting", Draft Report, Stanford Research Institute, 1975.
[Packet Radio, Time Sharing, Packet Communications]

This report describes some of the major considerations in the construction of small packet radio terminals. The radio transceiver, processor, and input-output devices are discussed. The Aloha Integrated Control it built at the University of Hawaii and an experimental unit being built at at Stanford Research Institute are discussed.

Fralick, S.C., Garrett, J.C., "Technological Considerations for Packet Radio Networks", Draft Report, Stanford Research Institute, 1975.
[Packet Communications, Packet Radio]

This paper discusses the applications of current technology to radio packet-switched systems, particularly to repeaters. The signal strength required for reliable transmission of data is discussed.

Frank, H., "Optimal Design of Computer Networks", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 167-183.
[Centralized System, Distributed System, Traffic Analysis, Routing, Network Design]

The design of both centralized and decentralized computer networks is considered, with particular emphasis on layout, link capacity assignment, delay analysis, and network route selection. Both general design problems and specific computational results are discussed.

Frank, H., Chou, W., "Network Properties of the ARPA Computer Net", Networks 4, John Wiley & Sons, Inc., 1974, pp. 213-239.
[ARPANET, Network Bandwidth, Packet Communication Analysis]

This paper starts with an overview of ARPA network techniques. Throughput and cost analyses are carried out for a variety of topological, cost, traffic, and line speed criteria. Reliability analyses are also made, with the primary objective of minimizing cost while maintaining reliability.

Frank, H., Chou, W., "Topological Optimization of Computer Networks", IEEE 60, Nov. 1972, pp. 1385-1397.
[Network Design, Network Topology, Centralized System, Distributed Computer Network, ARPANET, Reliability, Network Bandwidth]

Modeling, analysis and design problems, and methodologies for centralized and distributed computer-communication networks are discussed. The basic problem is to specify the location and capacity of each communication link within the network. The design objective is to provide a low-cost network which satisfies constraints of response time, throughput, reliability, and other parameters. (author's abstract).

Frank, H., Frisch, I.T., Chou, W., "Topological Considerations in the Design of the ARPA Computer Network", AFIPS SJCC, 1970, pp. 581-587.
[ARPANET, Network Design, Network Topology, Reliability, Routing, Network]

A design algorithm to establish where links should be established within the ARPA network is given. The algorithm presented obtains a local optimum. Some constraints are included in the decision, such as route selection, capacity assignment, link delay, etc. A graph of cost against throughput is presented to aid in choosing between local optima.

Frank, H., Frisch, I.T., Van Slyke, R., Chou, W.S., "Optimal Design of Centralized Computer Networks", Networks 1, 1971, pp. 43-57.
[Centralized System, Network Topology, Network Bandwidth, Network Modeling, Network Performance Optimization]

A design approach for centralized computer networks is presented. An algorithm to decide link capacities for an arbitrary cost structure is given and an example is studied. An algorithm to find locally optimal topologic solutions for the network is shown and an example given.

Frank, H., Kleinrock, L., Kahn, R.E., "Computer Communication Network Design--Experience with Theory and Practice", AFIPS SJCC 40, 1972, pp. 255-270.
[Distributed System Technology, Message Switching, Network Design, Store and Forward Communications, Resource Sharing, ARPANET, Network Topology, Modeling, Flow Control, Routing, Error Detection, Error Recovery]

Major problems relating to IMP design, topological design, and network modeling on the ARPA network are discussed and the major design techniques which have evolved to deal with them are given.

Frank, R.L., Yamaguchi, K., "A Model for a Generalized Data Access Method", AFIPS Conference Proceedings 43, 1974, pp. 45-52.
[Data Accessing, Information System Modeling]

This is a preliminary plan for a general information system model. The scheme is to have a set of data-independent access algorithms, driven by a high level language in which access methods may be described. Methods may then be tested, evaluated, and compared by simulation.

Freibergs, I.F., "The Dynamic Behavior of Programs", AFIPS FJCC, 1968, pp. 1163-1167.
[Measurement, Performance Evaluation, Paging]

This paper discusses program behavior (time between supervisor call, page requirements, etc.) for several classes of jobs (Fortran, Cobol, string manipulation, simulation, etc.) from observations of job mixes on an IBM 7044. Several interesting findings indicate that long compute sequences are rare and page requirements between supervisor calls are on the order of two or three pages. This leads the author to conclude that a "one page on demand" strategy should be prohibitively expensive.

Friedman, T.D., "The Authorization Problem in Shared Files", IBM Systems Journal 9, No. 4, 1970.
[Authorization, Data Accessing, Data Security, Privacy, Security]

The author develops a scheme for controlling access to data at the per-field level which can withstand almost all attempts at circumvention, with small effects to response time.

Gazis, D.C., "Modeling and Optimal Control of Congested Transportation Systems", Networks 4, 1974, pp. 113-124.
[Queueing Theory, Traffic Analysis, Store and Forward Networks]

An approach is discussed for the modeling of congested transportation systems as store-and-forward networks, analogous to communication networks.

Gelenbe, E., Tiberio, P., Boekhorst, J.C.A., "Page Size in Demand-Paging Systems", Proc. First Annual SIGME Symposium, 1973, pp. 1-12.
[Measurement, Performance Evaluation, Paging]

This paper discusses the problem of page size determination in demand paging systems. The effect of page size on various system performance measures is reviewed in detail. The paper also discusses the wasted space-time integral (WSTI) as a system performance measure, and uses it as a model for program and system behavior.

Ghosh, S.P., "File Organization: The Consecutive Retrieval Property", CACM 15, Sept. 1972, pp. 802-808.
[Data Clustering]

For a linear storage medium, it would be nice if all records retrieved by any one query were stored in consecutive locations and without redundancies. The possibility of so ordering a file (for a given query set) is studied in this paper. Clearly this possibility is remote for an extensive query set but may occur for important subsets.

Goldstein, R.C., Strnad, A.J., "The MacAIMS Data Management System", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1970, pp. 201-229.
[Relational Data System]

MacAIMS is a relational data management system in which the user need not know how the data is represented.

Gordon, W.J., Newell, G.F., "Closed Queueing Systems with Exponential Servers", Operations Research 15, No. 2, 1967, pp. 254-265.
[Queueing Theory]

This paper deals with constant population closed queueing networks. It is shown that such systems are stochastically equivalent to open systems in which the population may not exceed N. Equilibrium conditions for such a system is solved by a separation of variable technique.

Gordon, W.J., Newell, G.F., "Cyclic Queueing Systems with Restricted Length Queues", Operations Research 15, 1967, pp. 266-277.
[Network Modeling, Network Performance, Queueing Network, Queueing Theory, Congestion]

This paper is concerned with stochastic behavior of a system with capacity restrictions. The closed cyclic system considered is shown to be stochastically equivalent to open sysems in which the number of customers is a random variable. Duality is introduced (as holes moving in the opposite direction). Equilibrium equations for several systems are obtained.

Gorenstein, S., Galati, G., "Data Base Reorganization for a Storage Hierarchy", IBM Research Report RC 5063, October 1974.
[Data Clustering, Storage Management, Storage Hierarchies]

This paper suggests clustering together data which is likely to be retrieved together. The clusters then become blocks to be transferred between storage levels. A novel feature is the development of a replacement rule to determine which cluster in higher-level storage is to be replaced.

Gotlieb, C.C., Tompa, F.W., "Choosing a Storage Schema", Acta Informatica 3, 1974, pp. 297-319.
[Data Structures]

This paper contains a useful listing of storage structures (including definitions and diagrams) as well as a description of a facility for evaluating relative costs of the schema.

Graham, G.S., Denning, P.J., "Protection--Principles and Practice", AFIPS SJCC, 1972, pp. 417-429.
[Security, Protection, Access Control, Domain]

This paper builds upon Lampson's domains (FJCC 1969). An expanded domain scheme using a larger number of types of access is explained in detail, and proven correct. Implementation of the scheme is discussed, including comparisons with several existing operating systems (OS/360, RC 4000, Multics).

Graham, R., "Protection in an Information Processing Utility", CACM 11, May 1968, pp. 365-369.
[Protection, Privacy, Security, Access Control, Data Sharing]

Information processing utility properties which make protection necessary are discussed and the essential properties for a protection scheme are defined. An abstract model of the hardware features and companion software necessary to implement this model are described.

Greenfeld, N.R., "Quantification in a Relational Data System", AFIPS 43, 1974, pp. 71-75.
[Query Optimization]

A brief overview of relational data base theory is given including examples using LEAP. The author is primarily interested in methods to decrease the time required to answer a query. Some techniques include dynamic algorithm selection, iterative optimization and query tuning.

Griffith, A.K., "The GRAFIX-I Image Processng System", AFIPS NCC 43, 1974.
[Graphics]

GRAFIX-I is a hybrid system designed for high-speed processing and analysis of film images. It is a high resolution system and has been successfully applied to fingerprint classification, analysis of engineering drawings and various Optical Character Recognition (OCR) tasks. The actual image processing is done by a slave processor with Direct Memory Access (DMA) capability.

Grossman, D.D., Silverman, H., "Placement of Records on a Secondary Storage Device to Minimize Access Time", JACM 20, 1973, pp. 429-438.
[File Allocation]

The problem analyzed here is: given an n-frame device (e.g. a disk) and n records, plus times required to move from one frame to another and a probabilistic model of the access sequence, find that placement of records in frames which minimizes average access time.

Habermann, A.N., "Synchronization of Communicating Processes", CACM 15, Mar. 1972, pp. 171-176.
[Interprocess Communication, Multi-programming, Process Synchronization]

A formal process synchronization scheme that facilitates correctness proofs of inter-process interaction is described.

Hardgrave, W.F., "The Prospects for Large Capacity Set Support Systems Imbedded within Generalized Data Management Systems", International Computing Symposium 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1974, pp. 549-556.
[Set Theoretic Structures, Data Compression]

A method for maintaining and manipulating sets on mass storage is described. The main result of the paper is a compression technique for representing relatively small subsets of a large universe.

Harslem, E., Heafner, J., "Aspects of Large-Scale Resource Sharing through Networks of Computers", Rand P-4833, May 1972.
[ARPANET, Distributed Computing, Resource Sharing]

This paper discusses the desirability of distributed computer networks, and contains a description of ARPANET properties and development. A prognosis is given for network developments in the near future.

Hassing, T., Hampton, R., Bailey, G., Gardella, R., "A Loop Network for General Purpose Communication in a Heterogeneous World", Data Networks: Analysis and Design, DATACOM73, 1973, pp. 88-96.
[Network Topology, Protocol, Security, Data Sharing]

A packet switching data communictions network under development at the National Security Agency for resource sharing and future development of distributed processing and filing systems is described. The network will consist of a hierarchy of interconnected loops or rings, probably based on Bell System T carrier digital transmission technology. Also discussed are the means of nodal connection to the loops, nodal configuration, network protocols, design and security considerations, and implications for the future.

Hawryszkiewych, I.T., Dennis, J.B., "An Approach to Proving the Correctness of Data Base Operations", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1972, pp. 323-348.

[Relational Data System, Integrity]

The authors present an abstract model of a relational data base and primitive operations on this model which allow sharing of data and concurrent use of the data base.

Hayes, J.F., Sherman, D.N., "Traffic Analysis of a Ring Switched Data Transmission System", Bell System Technical Journal 50, November 1971, pp. 2947-2978.
[Traffic Analysis, Network Performance, Ring Network]

This paper is primarily concerned with the analysis of queueing delays in a ring (loop) data transmission system. The results are presented in a set of curves where delay (normalized to units of message length) is plotted as a function of number of stations and source activity. Detailed study is made of the uniform traffic pattern, where each user is identical and communicates equally. A computer simulation was performed and agreed well with the theoretical results.

Heart, F.E., Ornstein, S.M., Crowther, W.R., Barker, W.B., "A New Minicomputer/Multiprocessor for the ARPA Network", AFIPS NCC 42, 1973, pp. 529-537.
[Multiprocessor, ARPANET, IMP]

This paper describes the design of the high speed IMP for the ARPANET. The techniques described for interconnecting a number of storage media (a pruned n x n interconnection) provides a highly flexible structure for handling failures and a large variety of loads and speeds.

Heath, I., "Unacceptable File Operations in a Relational Data Base", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 19-34.
[Relational Structures, Data Integrity]

This paper is written within the context of a relational data base model as presented by E.F. Codd in "A Relational Model of Data for Large Shared Data Banks" and serves as a companion paper to his paper "Further Normalization of the Data Base Relational Model". The central thesis is that a file operation should not produce unexpected "side effects" in order to maintain a restriction (such as one-one, or many-one) on the file.

Herzog, B., "MERIT Computer Network", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 45-48.
[MERIT, Resource Sharing, Front End Processor, Distributed System, Network Design, Network Management]

The objectives and organization of the MERIT Computer Network are discussed from their inception through their projected future development. The historical and administrative compexities are presented. (author's abstract)

Hoffman, L.J., "The Formulary Model for Flexible Privacy and Access Controls", AFIPS 39, 1971, pp. 587-601.
[Access Control, Data Accessing, Privacy]

This paper discusses a method for using a set of procedures to dynamically control access to the information in a data base. This is done in such a way that access can be determined on a per item (rather than per file) basis.

Honeywell Info Systems and MIT, "Multics Project Administrator's Manual", Honeywell Info Systems and MIT, Feb. 1973.
[User Support, Management Support]

This document describes the support for a Project Administrator on a Multics system. The facilities include assigning resource limits to project members, load control, preemption, etc.

Hopgood, F.R.A., Davenport, J., "The Quadratic Hash Method When the Table Size is a Power of 2", Computer J. 15, 1972, pp. 314-315.
[Hashing]

This is a brief, readable discussion of quadratic hashing, with an analysis showing that it may be even more effective than had previously been thought.

Hornbuckle, G.D., "The Computer Graphics User/Machine Interface", IEEE Transactions on Human Factors, HFE-8, March 1967, p. 17.
[Display, Graphics, Interactive, Man-machine Communication, Terminals, Terminal Technology]

This paper discusses the use of a graphics terminal with a stylus-type input. Such a system would be superior to a conventional alphanumeric keyboard terminal for many tasks, e.g., editing, debugging, and circuit design.

Hsiao, D., Harary, F., "A Formal System for Information Retrieval From Files", CACM 13, 1970, pp. 67-73.
[Data Structuring, Information System Modeling, Retrieval Strategies]

This paper presents a generalized file structure which encompasses inverted, index-sequential, and multilist files, as special cases. An accompanying general retrieval algorithm is described in some detail.

Hsiao, D.K., "A Generalized Record Organization", IEEE Transactions on Computers, C-20, 1971, pp. 1490-1495.
[File System Design, Data Structures]

Working in the context of an example, the author discusses such concepts as field level, occurrence and repetition of an attribute, type and size of values, and keywords, linkages and pointers. He distills from this discussion parameters characterizing records and overall record organization.

Huang, J.C., "A Note on Information Storage and Retrieval", CACM 16, 1973, pp. 406-410.
[Data Structuring, Data Trees, Automatic Data Structuring]

An algorithm is given for constructing a data tree (or, more generally, a network) from a given set of data and binary relations among the data keys or identifiers.

Irby, C.A., "Display Techniques for Interactive Text Manipulation", AFIPS NCC 43, 1974, pp. 247-255.
[Display, Documentation, Graphics, Interactive, User Support]

Irby presents a detailed conceptual model for textual displays in an interactive environment. He lists seven requirements for the model, based on the concept that separate portions of the display (called "windows") may be handled in different fashions or by different programs. The model has been implemented on a TENEX as NLS.

Iseli, J., Poh, S., Sternick, H.J., "Description of a Proposed ARPANET HELP Facility", MITRE Technical Report MTR-6723, MITRE Corporation, McLean, Va.
[User Support, Documentation]

The need for on-line tutorial and other information in a heterogeneous computer network provides the impetus for a network-wide HELP facility. This paper discusses the pros and cons of several alternative implementations for such a facility. The alternative chosen is then discussed in greater detail showing what facilities would be necessary and how they could be provided.

Jackson, J.R., "Networks of Waiting Lines", Operations Research 5, 1957, pp. 518-521.
[Network Modeling, Queueing Theory, Queueing Networks]

'A machine shop' is described as a collection of departments, each with exponential service and exponential arrivals from outside the system. The steady-state distribution of the waiting-line lengths for each department is shown to be independent from that for other departments if mean arrival rate is properly defined.

Jackson, P., Stubbs, C., "A Study of Multiaccess Computer Communications", AFIPS SJCC, 1969, pp. 491-504.
[Time Sharing, Analysis, Measurement]

An analytical data stream model, used to describe communications between user and computer, is developed, and a statistical analysis is performed.

Jardine, N., van Rijsbergen, C.J., "The Use of Hierarchic Clustering in Information Retrieval", Inform. Stor. Retr. 7, 1971, pp. 217-240.
[Data Clustering, Retrieval Strategies]

The setting is document retrieval, where retrieval of all relevant items is not expected. The idea is to cluster the documents, match requests against various cluster "representatives", and return the best-matching cluster. Limited testing was done on a file of 200 documents.

Jervis, B., Parker, J.L., "An Approach for a Working Relational Data System", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1972, pp. 125-145.
[Relational Data System]

A data management system in which the user views his data as if it were in the relational form is described. It is not necessary that the data's physical structure be in the relational form.

Johnson, P.R., Thomas, R.H., "The Maintenance of Duplicate Databases", NIC #31507, Jan. 1975.
[Concurrent Use, Data Base Integrity, Distributed System]

This paper presents a method which (by representing each item in a data base as a quintuple containing information such as time created, time last modified, etc.) allows several distributed computers to maintain multiple copies of a data base in consistent states.

Jones, P.D., "Operating System Structures", IFIP Congress, 1968, pp. 525-530.
[Timesharing, Protection Hierarchy, Centralized Operating System]

Three existing operating systems are reviewed in terms of advantages and disadvantages. A very general description of some basic operating system concepts is given.

Kahn, R., "Terminal Access to the ARPA Computer Network", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 147-166.
[ARPANET, Store and Forward Communications, IMP, Resource Sharing, Time Sharing]

The goals and current developments in the ARPA Network are discussed. The characteristics of a Terminal IMP are described. The Terminal IMP (TIP) will permit direct connection to the ARPA Network.

Kalin, R., "Achieving Reliable Communication", RFC 203, NIC #7168, August 1971.
[Protocol, Communications, Error Detection, Error Recovery]

A non-standard protocol, suitable for either second or third level use, is proposed with the intent of providing error resistant and highly reliable communication channels. Errors introduced by message garbling, message loss, and message pickup are considered. Measures for increasing throughput are also discussed.

Karp, P.M., "Origin, Development, and Current Status of the ARPA Network", Proc. IEEE COMPCON73, 1973, pp. 49-52.
[ARPANET]

A slightly dated, but instructive, history of the ARPA Network with 19 references.

Karush, A.D., "Two Approaches for Measuring the Performance of Time-Sharing Systems", Proc. Second Symposium on Operating System Principles, Princeton, 1969, pp. 159-166.
[Measurement, Performance Evaluation, Queueing Theory, Benchmark]

This paper considers the "stimulus-black box" and analytic approaches to system measurements. The black box method is seen as cheaper and does not require intimate knowledge of the system. The two techniques are compared for cost, inconvenience, kinds of measurements, and other criteria.

Kaye, A., "Analysis of a Distributed Control Loop for Data Transmission", Computer Communications Networks & Teletraffic, J. Fox, ed., 1972, pp. 47-58.
[Data Transmission, Ring Network, Traffic Analysis, Distributed System]

The paper analyzes a loop system for the transmission of fixed length messages in which control is passed around the loop from terminal to terminal. Each terminal has a buffer of one message-length. Analytic formulae for the distribution, mean value, and variance of message waiting time, together with the proportion of blocked messages are obtained. Useful approximations for lightly loaded systems are also given. (author's abstract)

Kellogg, C., Burger, J., Diller, J., Fogt, K., "The Converse Natural Language Data Management System: Current Status and Plans", Proc. Symposium on Information Storage and Retrieval, ACM, 1971, pp. 33-46.
[Query Languages, Natural Language]

A natural-language compiler is described which accepts sentences in a user extendable English subset, produces surface and deep structured syntactic analyses, and uses a network of concepts to construct semantic interpretations.

Kernighan, B.W., Hamilton, P.A., "Synthetically Generated Performance Test Loads for Operating Systems", Proc. First Annual SIGME Symposium, 1973, pp. 121-126.
[Measurement, Performance Evaluation, Synthetic Jobs]

This paper describes the design and experience with an automated benchmark design facility. The system is divided into two parts: a simple, highly parameterized job, and a generator program that produces a ready-to-run job stream from a specification.

Kimbleton, S.R., Moore, C.G., "A Probabilistic Framework for System Performance Evaluation", Proc. ACM Workshop on System Performance Evaluation, 1971, pp. 337-361.
[Measurement, Performance Evaluation, Queueing Theory]

This paper describes a method for comparing throughput, turn-around time, and availability for a processor bound computer system. The authors feel the method is extendable to any system with a "clearly defined limiting resource". The paper also contains some very interesting data on process activity.

King, P.F., Collmeyer, A.J., "Database Sharing-An Efficient Mechanism for Supporting Concurrent Processes", AFIPS 42, 1973, pp. 271-275.
[Concurrent Use, Sharing of Data]

A lock-unlock mechanism, which provides for concurrent use of a data base and efficiently detects deadlock, is described.

King, P.F., Shemer, J.E., "ARS--An Interactive Reporting System", Proc. ACM SIGPLAN-SIGIR Interface Meeting, 1973, pp. 161-166.
[Query Languages]

A report-generating language is described. This system prompts the user for a description of the desired data and the display format.

Kleinrock, L, "Survey of Analytical Methods in Queueing Networks", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 185-205.
[Network Topology, Network Performance Optimization, Traffic Analysis, Nodal Blocking, ARPANET]

A brief survey of tools and methods used for the analysis of computer networks is presented. Queueing theory is applied to some simple cases and the results compared with those obtained from simulation and experiment. Discussion of the applicability of queueing analysis is given for more complex cases. (author's abstract)

Kleinrock, L., "Scheduling, Queueing, and Delays in Time-shared Systems and Computer Networks", Computer-Communication Networks, N. Abramson and F. Kuo, eds., Prentice Hall, pp. 95-141.
[Network Performance Optimization, Process Scheduling, Resource Allocation]

This paper consists of two nearly independent mathematical analyses based on queueing theory--the first part is a good review and analysis of the various time sharing scheduling algorithms. The second (and shorter) part discusses network analysis and optimization techniques.

Kleinrock, L., "Research Areas in Computer Communications", Computer Communication Review, SIGCOMM Quarterly Review 4, W. Chu, ed., July 1974, pp. 1-4.
[Communications, Distributed System, Flow Control, Resource Sharing]

The major research areas in computer communications are discussed. The specific problems emphasized by the author are: design of computer communication networks consisting of thousands of nodes, flow control in all networks, and the problems of privacy, security and resource control and allocation in distributed systems.

Kleinrock, L., "Certain Analytic Results for Time-shared Processors", IFIP Congress 68, pp. 838-845.
[Time Sharing, Terminals, Modeling, Queueing Theory, Traffic Analysis]

A basic model for time-shared systems with M consoles is introduced and analyzed. Published measurements on existing computer systems demonstrate the accuracy of the model in describing the behavior of the normalized average response time, taken as the performance measure of these systems. (author's abstract)

Kleinrock, L., "Analytic and Simulation Methods in Computer Network Design", AFIPS SJCC, 1970, pp. 569-579.
[Queueing Theory, ARPANET, Network Modeling, Network Bandwidth, Network Design, Network Performance, Routing]

Analytical techniques are used to analyze computer networks such as the ARPANET. Methods to synthesize an optimal channel capacity assignment are discussed for three different cost functions, including the real life case of the Telpak rates for leased transmission.

Kleinrock, L., Naylor, W., Opderbeck, H., "A Study of Line Overhead in the ARPANET", General InterNetwork Working Group Note #71, Sept. 1974.
[ARPANET, Packet Communication, Flow Control, Network Measurement, Network Performance, Traffic Analysis, Network Performance Optimization, Protocol, Congestion]

Communication channel overhead on the ARPANET is classified into levels of protocol hierarchy and studied for models of system use. Some measurements of line efficiency on the ARPANET are presented and extrapolations to a heavily loaded network are made. Results are derived for a recently suggested replacement for the HOST-HOST protocol and a comparison is made.

Knott, G.D., "A Proposal for Certain Process Management and Intercommunication Primitives", Operating Systems Review 8, Sections 1-6, October 1974, ACM Special Interest Groups on Operating Systems, pp. 7-44.
[Process Control, Interprocess Communication]

The types of process management and intercommunication capabilities found in advanced system implementations (Multics, Tenex, TSS, etc.) and in current operating system theory are characterized. The user-level primitives necessary to support these capabilities are described and some examples are given. An extensive bibliography is also provided.

Kobayashi, H., "Application of the Diffusion Approximation to Queueing Networks Part 1--Equilibrium Queue Distributions", Proc. First Annual SIGME Symposium, 1973, pp. 54-63.
[Measurement, Performance Evaluation, Diffusion Approximation, Queueing Networks]

This paper attempts to circumvent the constraints of queueing theory (namely oversimplified models), and apply diffusion process approximation to the modeling of computer systems.

Krinos, J.D., "Interaction Statistics from a Database Management System", AFIPS 42, 1973, pp. 283-290.
[Measurement]

Statistics gathered from monitoring the United Aircraft Information Management System are described. These include response time, cpu usage, and user think time.

Kudlick, M.D., "Network Mail Meeting Summary", RFC 469, March 1973.
[Mail, FTP, User Support]

This paper records a Network Working Group meeting held in March, 1973, which led to White's Mail Protocol. This paper provides good insights into the problems considered and possible solutions for a network mail facility and problems that were left open at this time. Many important points were considered, such as the roles of TIP's, the role of the Network Information Center, maintenance of addresses, etc.

Kuo, F.F., Abramson, N., "Some Advances in Radio Communications for Computers", Proc. IEEE COMPCON73, 1972, pp. 57-60.
[Packet Radio, Satellite Communications]

A brief description of the ALOHA System, a UHF broadcast radio system, which has been under development at the University of Hawaii since 1968. The hardware and data formats are very briefly described. The status of the ALOHA System and a description of satellite work in progress are also described.

Labonte, R.C., "A General Purpose Digital Communications System for Operation on a Conventional CATV System", Proc. IEEE COMPCON73, 1973, pp. 85-88.
[Communications]

Technical details of a two-way CATV System are presented. The system could be a prototype for a "wired city", in which subscribers can use the CATV system for communication. Possibilities mentioned include a "paperless office", "electronic mail", and "interactive education".

Lampart, L., "A New Solution of Dijkstra's Concurrent Programming Problem", CACM 17, Aug. 1974, pp. 453-455.
[Semaphore, Critical Section, Concurrent Processes]

A simple solution to the mutual exclusion problem is presented which allows the system to continue to operate despite the failure of any individual component (author's abstract).

Lampson, B.W., "Protection", Proc. Fifth Princeton Symposium on Information Sciences and Systems, March 1971, pp. 437-443.
[Access Control, Security]

Abstract models are given which reflect the properties of most existing mechanisms for enforcing protection or access control, together with some possible implementations. The properties of existing systems are explicated in terms of the model and implementations. (author's abstract)

Lampson, B.W., "A Note on the Confinement Problem", CACM 16, Oct 1973, pp. 613-615.
[Protection, Security, Privacy]

Some of the ways that a user's data could be "leaked" by a service program are discussed, and some comments are made on what confinement rules should be followed by an operating system to guard against this happening.

Lampson, B.W., "Dynamic Protection Structures", AFIPS FJCC, 1969, pp. 27-38.
[Security, Protection, Access Control, Domain]

This paper describes domains, or the set of capabilities (access rights) of a process. Most aspects of protection are discussed in this context, including passing permissions between domains, transfer of control between domains, and proprietary programs (mutually suspicious subsystems).

Land, R.I., Sutherland, I.E., "Real Time, Color, Stereo, Computer Displays", Applied Optics 8, March 1969, p. 721.
[Graphics]

A description is given of a color, 3-D graphics system which utilizes a rotating, synchronized wheel with colored and opaque segments, through which a CRT screen is viewed.

Lay, W., Mills, D., Zelkowitz, M., "Design of a Distributed Computer Network for Resource Sharing", AIAA Computer Network Systems Conference, Paper #74-426, 1973.
[Distributed Computing, Resource Sharing, Time Sharing, Fault Tolerance, Kernel, Virtual Memory, Interprocess Communication, Message Switching, Resource Management, Ring Network]

A distributed operating system for an integrated network of non-homogeneous minicomputers is proposed. Current distributed computer network designs are discussed. The general organization of the prototype Distributed Computer Network (at the University of Maryland) including storage management, interprocess communication (via messages and ports), and resource management is discussed.

Lefkovitz, D., "File Structures for On-line Systems", Spartan Books, 1969.
[File System Design, Retrieval Strategies]

This is a basic text on information systems. It includes chapters on directory decoding, file organization, file update and maintenance, etc.

Levien, R.E., Maron, M.E., "A Computer System for Inference Execution and Data Retrieval", CACM 10, 1967, pp. 715-721.
[Inferential Fact Retrieval]

This paper is concerned with the use of computers as assistants in the logical analysis of large collections of factual data. Two main issues are discussed: 1) what characteristics must the data base have, and 2) what is required in order to execute logical analysis of the data base.

Levin, K.D., "Organizing Distributed Data Bases in Computer Networks", Ph.D. Dissertation, U. of Penn., 1974.
[File Allocation]

Levin, building on the work of Chu and Casey, presents search-type algorithms for solving the file allocation problem when interactions between files (e.g. the use of files by program files) must be taken into account and some files are restricted to certain locations.

Lewin, M.H., "An Introduction to Computer Graphic Terminals", Proc. IEEE 55, Sept 1967, p. 1544.
[Graphics, Man-machine Communication, Terminals, Terminal Technology]

This paper describes the various different types of graphic devices available. Input and output are covered. The emphasis is on logical organization (e.g., how a picture is generated) and capabilities, rather than detailed design.

Licklider, J.C.R., "A Picture is Worth a Thousand Words-And it Costs...", AFIPS SJCC, 1969, p. 617.
[Graphics, Man-machine Communication, Terminals]

An introduction to an SJCC session on graphics which argues that insufficient use is being made of graphic terminals and their capabilities, and that such terminals are probably the best form of man-machine communication available.

Linde, R.R., Gates, R., Peng, T., "Associative Processor Applications to Real Time Data Management", AFIPS 42, 1973, pp. 187-195.
[Associative Processing]

This paper evaluates the comparative advantages of associative processing over conventional sequential processing as applied to data management functions and in particular the data management functions of the U.S. Air Force Tactical Air Control Center.

Lipinski, A., Lipinski H., Randolf, R., "Computer-Assisted Expert Interrogation: A Report on Current Methods development", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[Teleconferencing]

This paper discusses the present efforts of the Institute for the Future to use a teleconferencing system as a means for eliciting the judgements of experts for solutions of interdisciplinary problems. The paper discusses the problems of evaluating experts and integrating their opinions.

Loomis, D., "Ring Communication Protocols", Technical Report #26, Dept. of Information and Computer Science, University of California at Irvine, January 1973.
[Protocols, Message Transmission, Distributed Control, Ring Network]

A number of schemes for coordinating message transmission among computing components which are connected together by a single unidirectional, continuous and circular communication channel are discussed. The paper also examines mechanisms using distributed control to allow message transmission by node without interference from each other.

Lorie, R.A., Symonds, A.J., "A Relational Access Method for Interactive Applications", Data Base Systems, R. Rustin, ed., Prentice-Hall, 1972.
[Relational Data System, Data Languages]

This paper describes an experimental system that demonstrates interactive problem solving. The system is designed to meet the language and data base requirements of problem-solving. The components of the system are: a relational access method and an APL interpreter that provides the terminal user with the full facilities of APL/360. The data representation for a communications network design problem is discussed as an example.

Lum, V.Y., "Multi-attribute Retrieval with Combined Indexes", CACM 13, 1970, pp. 660-665.
[Data Accessing, Retrieval Strategies]

This paper generalizes the standard inverted file index scheme by proposing "compound" indices, in which records are indexed by an n-tuple of attribute values.

Lum, V.Y., "General Performance Analysis of Key-to-Address Transformation Methods Using an Abstract File Concept", CACM 16, 1973, pp. 603-612.
[Hashing]

This paper presents a theoretical method for analyzing and predicting the performance of hashing functions. The idea is to define a key "space" (consisting of all possible keys of a given form) and study the properties of the hashing function as a transformation on that space.

Lum, V.Y., Yuen, P.S.T., "Additional Results on Key-To-Address Transform Techniques: A Fundamental Performance Study on Large Existing Formatted Files", CACM 15, 1972, pp. 996-997.

[Hashing]

An addendum to Lum et al. (1971).

Lum, V.Y., Yuen, P.S.T., Dodd, M., "Key-To-Address Transform Techniques: A Fundamental Performance Study on Large Existing Formatted Files", CACM 14, 1971, pp. 228-239.
[Hashing]

This paper contains a careful study of eight different hash coding methods. The aim is to provide guidance as to which technique provides a most nearly uniform distribution of storage addresses in a given practical situation. See also Lum and Yuen (1972).

Luther, W., "Conceptual Bases of CYBERNET", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 111-146.
[CYBERNET, Time Sharing, Remote Job Entry, Store and Forward Communications, Distributed System, Message Switching]

This paper is a detailed description of CYBERNET--a currently operating, extensive, commercial network. The communication facilities and particular hardware configurations are described in detail. A discussion of the computer as a public utility is also included. (author's abstract)

Mader, E., "A Protocol Experiment", RFC 700, Aug. 1974.
[Host-Host Protocol, Network]

This paper discusses an implementation of the Internet protocol between a Tenex and PDP-11 at BBN. A discussion of some extensions to the protocol and the difficulties encountered is presented along with a theoretical analysis of the bandwidth capabilities of the protocol.

Mader, E., "Network Debugging Protocol", RFC 643, July 1974.
[Protocol, Debugging, User Support]

This document describes a protocol to implement a cross-net debugger for PDP-11's. The protocol bypasses the standard Host-Host protocol and assumes the remote machine is capable of performing low level debugging tasks.

Madnick, S.E., Alsop, J.W., "A Modular Approach to File System Design", AFIPS SJCC, 1969, pp. 1-13.
[File System Design]

This paper presents a general model for file system design based on hierarchical "modules" or successive layers of software between user and physical data. The authors note that such modular design should be particularly useful in a network.

Marron, B.A., de Maine, P.A.D., "Automatic Data Compression", CACM 10, 1967, pp. 711-715.
[Data Compression]

This paper seems to contain the earliest discussion of an automatic, language independent, alphanumeric string compressor.

Martel, C.C., Cunningham, I.M., Grushcow, M.S., "The BNR Network: A Canadian Experience with Packet Switching Technology", IFIP Congress 74, North Holland, 1974.
[Communication, Network]

This paper describes the initial work on a packet switched data network by Bell in Canada. The network is half-duplex with PDP-11's for message switches and interfaces IBM machines at three nodes.

Maurer, W.D., "File Compression Using Huffman Coding", Computing Methods in Optimization Problems 2, L. Zadeh, L. Neustadt, A. Balakrishan, eds., Academic Press, 1969.
[Data Compression]

This is the original paper on the use of Huffman codes for file compression. An algorithm for encoding is given in some detail. Maurer suggests that character combinations (e.g., common words) as well as single characters should be considered as "symbols" to be encoded.

McCarthy, J.P., "Automatic File Compression", International Computing Symposium 1973, A. Gunther, B. Levrat and H. Lipps, eds., North Holland, 1974.
[Data Compression]

The basic technique used here is Huffman coding. The paper is important because of the detailed description of an algorithm for automatic text analysis and selection of the strings to be encoded.

McCuskey, W., "On Automatic Design of Data Organization", AFIPS FJCC 1970, pp. 187-199.
[Set Theoretic Data Structures, Automatic Data Structuring]

This is largely a concepts paper, providing complicated terminology and descriptions for rather simple ideas. No solid results are given.

McKay, D., Karp, D., "IBM Computer Network/440", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 29-43.
[Distributed System, Telecommunications, Centralized System, Network Control Language]

Network/440 is a heterogeneous, general purpose computer network as well as a research project on networking problems. This paper describes the present design and implementation, and what are forseen as important problems in the field of networking.

McKay, D., Karp, D., "Protocol for A Computer Network", IBM Systems Journal 12, Jan. 1973, pp. 94-105.
[Protocol, Message Switching]

Message processing concepts and a protocol for communications control among network users are discussed.

McKenzie, A., "TELNET Protocol Specification", NIC #18639.
[TELNET Protocol, Protocol, Inter-process Communication, ARPANET]

The ARPANET Network Virtual Terminal (NVT), a canonicalization of the concept of an interactive computer terminal, is defined. The protocol used to communicate with an NVT is referred to as TELNET. This document describes the basic form of "negotiated options", the mechanism used to modify NVT behavior with respect to echoing, format effectors, etc. Particular options are defined in separate papers. This document is the TELNET reference document and may be updated or superseded at some future date.

McKenzie, A., "Host/Host Protocol for the ARPA Network", NIC #8246.
[Host-Host Protocol, Protocol, Inter-process Communication, ARPANET]

This document explains the philosophy of the host-host inter-process communication protocol used in the ARPA network. It then explains in detail the operations that must be performed to implement the protocol. This is the reference document for this protocol and is periodically updated.

McKenzie, A.A., Cosell, B.P., McQuillan, J.M., Thorpe, M.J., "The Network Control Center for the ARPA Network", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[ARPANET, Network Control, Network Management]

The NCC is responsible for detecting, locating, and correcting failures in the ARPANET IMP communications network. This paper discusses the hardware and software used to accomplish this, along with several measurement facilities.

McQuillan, J., "Software Checksumming in the IMP and Network Reliability", RFC 528, NIC 17164, June 1973.
[ARPANET, IMP, Reliability]

This paper describes in some detail modifications that were made to the ARPANET IMP and TIP programs to increase reliability. Some history is presented which led to the inclusion of software checksums for end to end checking of packets and checksums on IMP and TIP memories. Future plans for subnet changes are outlined.

McQuillan, J., "Response to RFC 567-Cross Country Network Bandwidth", RFC 568, NIC 18971, September 1973.
[ARPANET, IMP, Bandwidth, Flow Control, Traffic Analysis]

Many salient points ommitted in RFC 567 are underscored. The reason for tardy character echoing is attributed to delay in the hosts and subnet instead of bandwidth.

McQuillan, J., Crowther, W., Cosell, B., Walden, D., Heart, F., "Improvements in the Design and Performance of the ARPA Network", AFIPS FJCC, 1972, pp. 741-754.
[ARPANET, IMP, Network Design, IMP-IMP Protocol, Flow Control, Store and Forward Networks, Packet Communication, Network Measurement, Network Performance Optimization, Congestion, Deadlock]

New algorithms in the areas of source-to-destination sequence control, source-to-destination flow control, and IMP-to-IMP transmission control are given as a result of the discovery of logical flaws in the interface message processor (IMP) software. Changes in program structure are discussed. Measurements of network throughput, IMP reliability, and IMP performance are given.

Mendicino, S., "OCTOPUS: The Lawrence Radiation Laboratory Network", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 95-110.
[Centralized System, OCTOPUS, Distributed System, Data Transmission]

The evolution of the Lawrence Radiation Laboratory Livermore OCTOPUS from a centralized network to a distributed one, consisting of a superimposition of specialized sub-networks, is described.

Metcalfe, R., "Packet Communication", Rpt. #MAC TR-114, Project MAC, MIT, Dec. 1973.
[Protocol, Packet Communication, ARPANET, ALOHA, Network Bandwidth, Interprocess Communication, Thin-line Communications, Satellite Communication]

This report develops a theory of packet communication: it analyzes uses of computers in digital communication systems and examines structures for organizing computers in highly communicative environments. Various examples from existing computer networks are used to motivate and substantiate analysis of store-and-forward packet communication, broadcast packet communication, and distributed interprocess communication. Bandwidth, protocols, inter-node spacing, packet lengths, and other aspects of packet communication are examined from the standpoint of underlying theory.

Metcalfe, R., "Strategies for Interprocess Communication in a Distributed Computing System", Computer and Communications Networks and Teletraffic, J. Fox., ed., 1972, pp. 519-525.
[ARPANET, Protocol, Routing, Error Recovery, Interprocess Communication, Message Switching, Distributed System Technology, Ports]

Characteristics are given for distributed and centralized systems processes and protocols. Thin-wire (distributed) interprocess communication is explained and it is suggested that it should be used more generally in computer operating systems for reliability reasons.

Michael, G.A., Cralle, R.K., "A Survey of Graphic Data Processing Equipment for Computers", Computer Oriented Circuit Design, F. Kuo and W. Magnuson, eds., Prentice-Hall, 1969.
[Graphics, Terminal, Terminal Technology]

A survey of graphic input and output (light pen and "picture readers") devices that contains tables comparing several vendors' models. A number of desirable hardware and software features for graphics input and output in the future are discussed.

Miller, E.F., Pritchard, E.L., "Process Control and File Management in Large Minicomputer Networks", Proc. IEEE COMPCON73, 1973, pp. 199-201.
[Computer Networks]

A proposal for providing a "floating" operating system (BOSS) which delegates authority as needed to "junior executives" (JEXs). "The study of the requirements for the control program(s) and the data management functions is anthropomorphic." A hierarchical structure similar to that of large companies is recommended for large minicomputer networks. Reliability problems with hierarchical structure in a distributed environment are not addressed.

Miller, S.W., "Display Requirements for Future Man-Machine Systems", IEEE Transactions on Electronic Devices, ED-18, Sept. 1971, p. 616.
[Graphics, Man-machine Communication, Interactive]

This paper discusses the need for interactive graphic devices. The major point made is that 8 1/2 by 11 inch, black-on-white, high resolution, inherent memory devices that rely on reflected light would be a big step toward insuring general acceotance of interactive graphics.

Miller, T.J., "Deadlock in Distributed Computer Networks", Rpt. #UIUCDCS-R-74-619, Dept. of CS, Univ. of Ill., Urbana, Dec. 1974.
[Deadlock, Process synchronization]

This paper discusses deadlock detection in a centrally controlled environment, in which a single resource manager performs allocation, and in a distributed control environment, in which processes perform their own resource allocation. Shared memory for residence of Dijkstra semaphores and other data structures are assumed, so the title is somewhat midleading.

Mimno, N.W., Cosell, B.P., Walden, D.C., Butterfield, S.C., Levin, J.B., "Terminal Access to the ARPA Network: Experience and Improvements", Proc. IEEE COMPCON73, 1973, pp. 33-43.
[TIP, ARPANET]

A superficial look at the background, history, design, and continuing development of the ARPANET Terminal IMP (TIP).

Mommens, J.H., Raviv, J., "Coding for Data Compaction", IBM Research Report RC 5150, November 1974.
[Data Compression]

This is a belated report on old (ca. 1970) compression work done at IBM. Several approaches are described with emphasis on software and hardware implementation. Results of experiments on real data are given.

Morgan, D.E., Campbell, J.A., "An Answer to a User's Plea?", Proc. First Annual SIGME Symposium, 1973, pp. 112-121.
[Measurement, Performance Evaluation, Benchmark, Synthetic Jobs]

This paper discusses the subject of performance evaluation from the point of view of the user. Problems of how to choose machines, configurations, etc., are discussed. Also, two forms of benchmarks (resource and service demand) and their applicability to various environments are discussed.

Morgan, H.L., Levin, K.D., "Optimal Program and Data Locations in Computer Networks", Report 74-10-01, Dept. of Decision Sciences, The Wharton School, U. of Penn., 1974.
[File Allocation]

This is a brief summary of Levin's Ph.D. thesis (q.v.) on the network file allocation problem.

Morris, J.H., "Protection in Programming Languages", CACM 16, Jan. 1973, pp. 15-21.
[Access Control, Protection]

This paper discusses protection of subprograms from malfunctions of other subprograms. Methods of enforcing user-created type restrictions thru software and restriction of variables to specific programs are discussed.

Morris, R., "Scatter Storage Techniques", CACM 11, 1968, pp. 38-43.
[Hashing]

This is a good review of the early work on hashing.

Moulder, R., "An Implementation of a Data Management System on an Associative Processor", AFIPS 42, 1973, pp. 171-176.
[Associative Processing]

An experimental data management system using an associative processor (AP) is discussed. The database resides on a parallel-head-per-track disk connected to the AP via 72 parallel channels.

Mulford, J.B., Ridall, R.K., "Data Compression Techniques for Economic Processing of Large Commercial Files", Proc. Symposium on Information Storage and Retrieval, ACM, 1971, pp. 207-215.
[Data Compression]

The authors used a combination of schemes (elimination of obvious data redundancies, coding of lengthy fields which were inconvenient to code on input, Huffman coding, etc.) to achieve a 4.7 compression ratio on a large commercial data base.

Mullin, J.K., "The Specification of Data Structures, Access Methods, and Efficiency ", Proceedings Sixth Annual Princeton Conference on Information Sciences and Systems, 1972, pp. 79-84.
[File System Design, Access Paths, Information System Modeling]

This paper describes a file system simulation program: given information on the data and its structure, as well as retrieval mechanisms and basic costs, retrieval "activities" are simulated and activity costs generated.

Multics, "System Administrator's Manual", Honeywell Info Systems and MIT, Feb. 1973.
[Accounting, User Support, Management Support]

This document describes the capabilities and functions provided the System Administrator of a Multics system. The facilities described include resource control, billing, creating new users, etc.

Muntz, R.R., "Analytic Models for Computer System Performance Analysis", UCLA Computer Science Department Quarterly 2, Jan. 1974, pp. 49-66.
[Network Performance, Network Modeling, Queueing Theory]

Descriptions of several queueing theoretic models are given (Kleinrock's, Buzen's, Moore's, etc.) and restrictions and future developments are described. Some emphasis is put on the author's model which is the only one with different customer classes.

Naylor, W.E., "Real-time Transmission in a Packet Switched Network", Network Measurement Note 15, NIC 19014, Sept 1973.
[ARPANET, IMP, Packet Communication, Measurement, Data Transmission, Packet Communication Analysis]

An experiment was performed on the ARPA network to measure the transmission data rate that one could get for different message sizes. Messages of sizes 1, 40, 62 and 503 words were sent through 1, 3, and 6 "hops" (one hop is transmission from one IMP to a neighboring IMP). Finally, results from a theoretic model are compared with the data.

Needham, R., "Protection-A Current Research Area in Operating Systems", International Computing Symposium, 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1974, pp. 123-126.
[Protection, Security, Access Control, Process Synchronization]

An approach to protection, involving the notion of "regimes of protection" which denote the data a process can access, the variety of access permitted, that selection of other processes it may call, and transitions available to other regimes of protection, is presented. Advantages and disadvantages inherent in the scheme and its implementation are discussed.

Neiger, N., "Comments on CCL", NIC 30071, 1974.
[User Support, Command Language, Network Command Language]

This paper discusses the proposal of the UULP on the ARPANET (see Tentative Proposal for a Unified User Level Protocol). This author sees the main problems as a contention between standardization and resource sharing, and suggests Thomas' view (see Comments on the Common Command Language Effort) as the best solution rather than resolving the contention as Padlipsky proposed.

Neigus, N., "The File Transfer Protocol", RFC 542, July 1973.
[Protocol, FTP]

This document provides the most recent definition of the FTP for the ARPANET. The reader should also be aware of the subsequent RFC 640 on the new reply code structure. FTP provides the means for moving files regardless of internal structure between two hosts.

Neuhold, E.J., "Data Mapping: A Formal Hierarchical and Relational View", Sixth Courant Computer Science Symposium, 1971.
[Data Structures]

A formal description of hierarchical and relational views of data is given. It is then shown that the two different structures have very close interrelations. This facilitates the definition of formal mapping between the two.

Nielsen, N., "The Simulation of Time Sharing Systems", CACM 10, July 1967, pp. 397-413.
[Measurement, Performance Evaluation, Simulation]

The paper describes a fairly effective and general time-sharing simulator. The simulator is designed to accommodate a large class of (if not all) timesharing systems, and to allow appraisal of various systems and configurations.

Nishihara, S., Hiroshi, H., "A Full Table Quadratic Search Method Eliminating Secondary Clustering", Int. J. Comp. Inform. Sci. 3, 1974, pp. 123-128.
[Hashing]

This paper describes a variation on quadratic hashing which searches the whole memory, eliminates secondary clustering, and requires no division operation.

Opderbeck, H., "Throughput Degradations for Single Packet Messages", RFC 632, NIC 30239, May 1974.
[ARPANET, Flow Control, IMP]

An experiment to measure the bandwidth of single packet message transmission on the ARPANET is reported. Only one fourth of the expected throughput was achieved in many cases. The IMP flow control mechanism is shown to be at fault and two solutions are proposed.

Opderbeck, H., Kleinrock, L., "The Influence of Control Procedures on the Performance of Packet-Switched Networks", Inter Network Working Group Note #62, Sept. 1974.
[Packet Communication Analysis, Deadlock, Error Detection, Error Recovery, Flow Control, ARPANET, Network Performance, Congestion]

The general aims and problems of flow control are discussed as they relate to the ARPANET. Some deadlocks and degradations which have been discovered are discussed.

Ophir, D., Shepherd, B.J., Spinrad, R.J., "Three-Dimensional Computer Display", CACM 12, June 1969, p. 309.
[Graphics]

A short description of a system which generates 3-D line displays using a color TV monitor and colored filters over the viewers eyes is given.

Ortany, A., "A System for Stereo Viewing", Computer Journal 14, May 1971, p. 140.
[Graphics]

A stereographics system using polarized lenses and a transmitting/reflecting surface to fuse images is described. It can be viewed by many people at once.

Owens, R., "Evaluation of Access Authorization Characteristics of Derived Data Sets", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 263-278.
[Data Security]

The capabilities necessary for preserving privacy in the context of a large scale data management system designed to support nontrivial decision making is described. This paper details a technique for providing those capabilities in a relational data management system and demonstrates the feasibility of a system which goes part way toward providing an environment in which privacy can be protected; moreover, it is shown that providing this environment will not be an easy task.

Padlipsky, M.A., "Specification of the Unified User-Level Protocol", RFC 666, NIC #31396, 1974.
[Protocol, UULP, Time Sharing, Man-machine Communication, ARPANET]

This paper proposes and describes a user-level man and machine usable protocol for standardizing the user interface to time sharing systems. This allows a user or machine to perform many site-independent actions in a site-independent command language. Standardized input conventions and an initial set of commands are described.

Padlipsky, M.A., "A Proposed Protocol for Connecting Host computers to ARPA-like Networks via Front-end Computers", RFC #672, 1974.
[Protocol, ARPANET, Front-end Processor]

This RFC defines a highly flexible protocol for communication between a front-end and a host with significantly less impact on the host than a full NCP in the host. The paper also contains highly relevant "advice" to would-be designers and implementers of network functions.

Padlipsky, M.A., "Tentative Proposal for a Unified User Level Protocol", RFC 451, Feb. 1974.
[User Support, UULP, Command Language]

This is the first of a series of papers on a more unified approach to network services on the ARPANET. The proposal discusses the proliferation of contact sockets for new service protocols, and the duplication of effort sometimes necessary because of the approach.

Padlipsky, M.A., "Comments on CCL.DOC", USING CCL committee paper, 1974.
[Network Command Language, User Support, Command Language]

This paper contains Padlipsky's response to Thomas' comments (see Comments on the Common Command Language Effort). This paper addresses each point of Thomas' paper. This whole series makes good reading for the designer of a network command language.

Padlipsky, M.A., "Beyond the Telephone Line Surrogate: Specification of the Unified User Level Protocol", USING Note, 1974.
[User Support]

This paper is the predecessor of RFC 666. It is listed here mainly for completeness and the discussion it provoked.

Padlipsky, M.A., "Two Solutions to a File Transfer Access Problem", RFC 505, July 1973.
[Access Control, Accounting, File Transfer Protocol, Security]

This RFC addresses the problems of file access and accounting for file transfers in a network without network-wide accounting. The author offers two solutions which have been used and discusses their implications (See also RFC's 487 and 501.)

Padlipsky, M.A., "What is 'Free'?", RFC 491, Apr. 1973.
[File Transfer Protocol, Access Control, Security]

This RFC discusses the problems of free system access to provide services such as mail. The problem of the necessity of login is discussed, and several solutions are entertained.

Padlipsky, M.A., "NETED: A Common Editor for the ARPA Network", RFC 569, Oct. 1973.
[Resource Sharing, User Support, Editor]

This document provides a functional description of a common network editor. The editor is based on the Multics editor, EDS. This choice was made because of its simplicity and ease of definition.

Padlipsky, M.A., Calvin, I., Kudlick, M., Greer, C., Crocker, D., "Design Document for a Performance Measurement Laboratory", USING Internal Memo, 1974.
[Performance Evaluation, Measurement, User Support]

The measurement and authentication of services on a network are highly important, not only to determine the best place to get a job done, but also to determine if protocols are implemented correctly and efficiently. This paper discusses a technique for performing that function.

Page, E.S., Wilson, L.B., "Information Representation and Manipulation in a Computer", Cambridge Univ. Press, 1973.
[Data Structuring, Data Trees, Hashing]

This book is an excellent elementary introduction to the basics of computer information handling.

Parhami, B., "A Highly Parallel Computing System for Information Retrieval", AFIPS FJCC 41, 1972, pp. 681-690.
[Associative Processing]

A rotating associative processor, RAPID, is described. Design criteria are given along with logic diagrams.

Parhami, B., "Associative Memories and Processors: An Overview and Selected Bibliography", Proc. IEEE 61, June 1973, pp. 722-730.
[Associative Processing]

An overview of hardware and software techniques used with associative memories is given. There are 171 references.

Patil, S.S., "Limitations and Capabilities of Dijkstra's Semaphore Primitives for Coordination Among Processes", Computation Structures Group Memo 57, Project MAC, MIT. Feb. 1971.
[Process Synchronization, Semaphore, Interprocess Communication]

The "cigarette smoker's problem", a representative of a class of coordinations that cannot be performed with Dijkstra's P and V primitives without conditionals, is presented. An extension to the P and V primitives is proposed.

Patt, Y.N., "Variable Length Tree Structures Having Minimum Average Search Time", CACM 12, 1969, pp. 72-76.
[Data Structures, Data Trees]

This paper contains two types of theorems on tree structures: One type dealing with optimal search orders for completely specified trees, and one dealing with construction of trees having minimum average search lengths if only the total number of leaves is specified.

Patterson, A.C., "Requirements for a Generalized Data Base Management System", AFIPS FJCC 39, 1971, pp. 515-522.
[Data Management Overview, Security, Data Accessing]

This paper briefly discusses the GUIDE/SHARE report on generalized requirements of data management systems. It contains more than two pages of glossary of data management-type terms, which may be of some use to the novice.

Pewitt, T.C., Su, S.Y.W., "Resource Demanded Paging and Dispatching to Optimize Resource Utilization in an Operating System", Proc. First Annual SIGME Symposium, 1973, pp. 29-36.
[Measurement, Performance Evaluation, Queueing Theory]

This paper uses Buzen's model for evaluation of an operating system. The authors then apply an iterative optimization scheme to determine optimum system parameters.

Pogran, K.T., "Unmuddling Free File Transfer", RFC 501, May, 1973.
[Access Control, Accounting, File Transfer Protocol, Security]

This RFC elaborates on the suggestions made in Bressler's RFC 487. The author examines the problem from another point of view and points up several difficulties in security and accounting. Also see RFC's 487 and 505.

Popek, G.J., "Protection Structures", Computer, June 1974, pp. 22-33.
[Access Control, Data Security, Privacy, Protection, Security]

This paper starts with a general discussion of privacy and security. It then surveys control disciplines and protection models in some detail, with numerous references to the literature (84 references).

Popek, G.J., Kline, C.S., "Verifiable Protection Systems", To be presented at the ACM/IEEE Software Reliability Conference in LA, CA., Apr. 1975.
[File System Design, Kernel, Access Control, Data Security, Privacy, Protection, Security, Co-operating Processes, Multi-programming]

This paper primarily describes the UCLA/VM project at UCLA. UCLA/VM is a PDP 11/45-based virtual machine kernel that is verifiable, secure, and a virtualizing package that creates virtual PDP 11/45's.

Popek, G.J., Kline, C.S., "Verifiable Secure Operating System Software", AFIPS NCC, 1974, pp. 145-151.
[Access Control, Data Security, Privacy, Protection, Kernel, Security, Co-operating Processes, Multi-programming]

This paper discusses some aspects of secure operating systems, describes the concepts of security kernels and virtual machines, mentions several difficult security problems, and briefly mentions some aspects of verification of security kernels. The UCLA-VM system, a prototype security kernel and support software for the PDP 11/45, is mentioned briefly. Brief arguments concerning the cost of security are presented.

Postel, J., "Official Initial Connection Protocol", NIC #7101.
[Initial Connection Protocol, Protocol, Inter-process Communication, ARPANET]

This document describes the ARPANET Initial Connection Protocol (ICP), a protocol used to establish an inter-process communication link between two hosts. This is the official ICP document, and may be updated or superseded.

Pouzin, L., "A Proposal for Interconnecting Packet Switching Networks", InterNetwork working Group Note #60, March 1974.
[Packet Communication, Store and Forward Networks, Gateway, Network Interconnection]

A proposal to allow point to point message transfer across several independent packet switching networks is described. Necessary protocols and possible constraints are discussed.

Pouzin, L., "Presentation and Major Design Aspects of the CYCLADES Computer Network", Proc. Third Data Communication Symp., IEEE, Nov. 1973.
[CYCLADES, Host-Host]

The design of a packet switched network being developed in France is presented. The paper gives a cursory overview to their approach and plans for the future. The approach taken by this group is significantly different from other packet switched networks.

Pouzin, L., "CIGALE, The Packet Switching Machine of the CYCLADES Computer Network", IRIA MIT 556, Nov. 1973.
[CYCLADES, Communication Subsystem, Flow Control, Congestion, Routing]

This paper describes the design of the packet switching nodes of the CYCLADES network. The nodes, French MITRA 15's, implement the routing, flow control and other functions necessary for the maintenance of the communications subnetwork.

Quatse, J., Gaulene, P., Dodge, D., "The External Access Network of a Modular Computer System", AFIPS SJCC 40, 1972, pp. 783-789.
[Resource Sharing, Security, Message Processing, PRIME, Protection, Error Detection, Inter-process Communication]

The PRIME system consists of sets of modules dynamically reconfigured into separate subsystems. Three classes of communications are needed: processor-to-processor, processor-to-facility pool device-(e.g. disk drive), primary memory-to-facility pool device. This paper describes the structure and components of the External Access Network (EAN) developed for this purpose.

Ramamoorthy, C.V., Chandy, K.M., "Optimization of Memory Hierarchies in Multiprogrammed Systems", JACM 17, 1970, pp. 426-445.
[File Allocation, Memory System Design]

The techniques described may be used to determine at what levels files should be stored or to determine the design of the memory hierarchy (given data on file sizes and query frequencies). Mean response time is minimized under a total cost constraint. The algorithms use linear programming and branch-and-bound.

Ramamoorthy, C.V., Chin, Y., "An Efficient Organization of Large Frequency-Dependent Files for Binary Searching", IEEE Trans. Comp. C-20, 1971, pp. 1178-1187.
[File Partitioning]

The basic idea here is to partition the file into blocks of 2**j-1 items (for efficient binary search), all items in a block expected to be accessed with similar frequencies. The scheme is most appropriate to single item searches.

Reardon, B.C., "An Adaptive Information Retrieval System Using Partial File Inversion", Inform. Stor. Retr. 10, 1974, pp. 49-56.
[Data Structuring, Automatic Data Structuring, Data Accessing]

This paper proposes an automatic, adaptive scheme for generating an inverted file. Keywords (or attribute values) involved in a query are first searched for in the inverted file. If not found, the file is searched sequentially and the result is entered into the inverted file as well as used to answer the query.

Rettenmayer, J.W., "File Ordering and Retrieval Cost", Inform. Stor. Retr. 8, 1972, pp. 79-93.
[Data Clustering]

This paper proposes that for efficient retrieval data should be clustered according to similarity of keys, and members of clusters should be stored together. Unlike document retrieval, where only the cluster representatives (or centroids) are examined for similarity to a query, here the centroids provide a guide as to which clusters are to be searched. Simulation experiments are reported on.

Roberts, L., Wessler, B., "Computer Network Development to Achieve Resource Sharing", AFIPS SJCC, 1970, pp. 543-549.
[ARPANET, Resource Sharing, Store-and-forward Networks, Network Topology, Network Design]

This slightly dated article gives the requirements, properties, and topology of the communications system chosen for the ARPANET. A quantitative comparison is made between the chosen ARPANET configuration and alternative network communications systems designs.

Roberts, L.G., "Extensions of Packet Communication Technology to a Hand Held Personal Terminal", AFIPS SJCC, 1972, pp. 295-298.
[Packet Radio, Packet Communications]

The feasibility of a hand-held computer terminal using packet radio techniques is discussed. The terminal would consist of a 256-character plasma screen, a five-button keyset, a radio transceiver, and control logic. A brief comparison of the random-access radio technique used with conventional frequency or time-division multiplexing is included.

Rose, G.A., "Computer Graphics Communications Systems", IFIP Congress 68, North Holland, 1968, p. 692.
[Communications, Graphics, Network, Terminal Technology]

Directly-coupled and buffered displays are briefly described. Three experimental systems are compared and discussed: ARDS project, Intergraphic project, IBM 1500 Instructional Display System. Linking of a large number of such devices into a network is discussed.

Rothnie, J.B.,Jr., Lozano, T., "Attribute Based File Organization in a Paged Memory Environment", CACM 17, 1974, pp. 63-69.
[Hashing, Data Clustering, Data Structuring]

This paper suggests the computation of hash addresses ("pages" instead of single locations) as a function of several keys. This not only reduces search time (or the need for inverted files) but also clusters the data conveniently.

Rotwitt, T.,Jr., deMaine, P.A., "Storage Optimization of Tree Structured Files Representing Descriptor Sets", Proceedings 1971 ACM SIGFIDET Workshop, E.F. Codd and A.L. Dean, eds., pp. 207-217.
[Data Structures, Data Trees]

Files may be naturally structured into trees on the basis of the values taken on for the various attributes (keys). The number of nodes in the tree will vary according to which key is assigned to which level. This paper addresses the problem of determining an optimal arrangement.

Rozawadowski, R.T., "A Measure for the Quantity of Computation", Proc. First Annual SIGME Symposium, ACM, 1973, pp. 100-111.
[Measurement, Performance Evaluation, Information Theory]

This paper is interesting from two aspects: it nicely parallels Holstead's software physics work, and it provides a very reasonable machine independent measure of computational work. This measure may then be used to compare machine instruction sets, which the paper does.

Rustin, R., "Computer Networks", Prentice-Hall, 1972.
[MERIT, OCTOPUS, DCN, CYBERNET, ARPANET, Computer Network]

This book is a series of articles on computer networks which were given at the Courant Institute of Mathematical Sciences at New York University Symposium on November 30-December 1, 1974. Authors and titles are: A. Weis, "Distributed Network Activity at IBM", B. McKay, D. Karp, "IBM Computer Network/440", B. Herzog, "MERIT Computer Network", A. Aupperle, "MERIT Computer Network: Hardware Considerations", A. Cocanower, "MERIT Computer Network: Software Considerations", D. Farber, "Data Ring Oriented Computer Networks", S. Mendicino, "OCTOPUS: The Lawrence Radiation Laboratory Network", W. Luther, "Conceptual Bases of CYBERNET", R. Kahn, "Terminal Access to the ARPA Computer Network", H. Frank, "Optimal Design of Computer Networks", L. Kleinrock, "Survey of Analytical Methods in Queueing Networks". For more complete annotations, see each individual author and title.

Ruth, S.S., Kreutzer, P.J., "Data Compression for Large Business Files", Datamation, Sept. 1972, pp. 62-66.
[Data Compression]

This is a good review and evaluation of compression techniques particularly applicable to large military data bases. The authors recommend Huffman coding of characters plus common patterns, and have obtained a 2.5 compression ratio on a large, dense data base.

Saltzer, J.H., "Protection and the Control of Information Sharing in Multics", CACM 17, July 1974, pp. 338-402.
[MULTICS, Security, Privacy, Access Control, Data Sharing, Time Sharing, Virtual Memory, Storage Hierarchies]

Design principles and goals of Multics, a highly secure time-sharing system, are described. The schemes Multics uses to implement the design goals are described in detail, and a discussion of the tradeoffs and weaknesses of the implementation is included. The design principles and access control, authentication, and protection mechanisms discussed in this paper are important concepts in the field of secure operating systems.

Saltzer, J.H., Gintell, J.W., "The Instrumentation of Multics", CACM 13, Aug. 1970.
[Measurement, Performance Evaluation]

This paper describes in a cursory manner the measurement facilities provided in Multics. Both hardware and software techniques are presented ranging from a PDP-8 based monitor to evaluation by running a script of user activities.

Schmid, H., "An Approach to the Communication and Synchronization of Processes", International Computing Symposium 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1973.
[Process Synchronization, Inter-process Communication, Petri Nets, Resource Sharing, Deadlock]

Primitives for the communication of concurrent processes are introduced. Using these primitives, process systems are split into processes independent of, and processes communicating with the environment, which allows easy transformation of process systems into Petri Nets. Finally, the implementation is discussed.

Schroeder, M., Saltzer, J., "A Hardware Architecture for Implementing Protection Rings", CACM 15, March 1972, pp. 157-170.
[Protection, Security, Access Control, MULTICS, Virtual Memory]

Criteria are presented for the design of access control mechanisms, and the processor mechanisms for implementing protection rings are described. Finally, advantages and possible uses for protection rings are discussed.

Schroeder, M.D., "Cooperation of Mutually Suspicious Subsystems in a Computer Utility", Report #MAC TR-104, Project MAC, MIT.
[Security, Access Control, MULTICS]

A protection scheme based on capabilities and protection domains is described. The scheme is efficiently implementable in hardware and extends the methods developed for and implemented by the Honeywell 6180 MULTICS processor. Impacts of the design on the supporting operating system are discussed.

Schuyler, J., "ORACLE: Computerized Conferencing in a Computer-Assisted-Instruction System", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[Teleconferencing]

This paper describes a teleconferencing system developed for the social sciences to augment the effectiveness of the questionaire by utilizing a modified Delphi technique.

Schwartz, J.T., "Abstract and Concrete Problems in the Theory of Files", Data Base Systems, R. Rustin, ed., Prectice-Hall, 1972, pp. 1-21.
[Data Structuring, Data Accessing, Retrieval Strategies, File System Design]

In this symposium talk given in May, 1971, Schwartz outlined the key problems that should be addressed in developing the area of data base management.

Sekino, A., "Throughput Analysis of Multiprogrammed Virtual Memory Computer Systems", Proc. First Annual SIGME Symposium, 1973, pp. 47-53.
[Measurement, Performance Evaluation, Paging, Queueing Theory]

This paper combines models of paging behavior of programs under multiprogramming, and of dual processor, multi-memory system with virtual memory to realistically evaluate throughput. The model is compared with actual data from MULTICS, and the effect of multiprogramming is evaluated.

Senko, M.E., "Details of a Scientific Approach to Information Systems", Data Base Systems, R. Rustin, ed., Prentice-Hall, 1972, pp. 143-174.
[Information System Modeling, Information System Measurement, File System Design]

This 1971 Symposium talk is a good, readable introduction to information system modeling in general and Senko's FOREM in particular. (See other papers by Senko et al.)

Senko, M.E., "Data Description Language in the Context of a Multilevel Structured Description: Diam II With Foral", IBM Research Report RC 5073, 1974.
[Data Description Language]

A five level data description language is described. These levels are the end user, information, string, encoding, and physical levels.

Senko, M.E., Altman, E.B., Astrahan, M.M., Fehder, P.L., "Data Structures and Accessing in Data-Base Systems", IBM Systems Journal 12, 1973, pp. 30-93.
[Data Structuring, Data Accessing, Information System Modeling]

This paper is in three parts: I. Evolution of Information Systems (an overview of the development and problems of data-base systems) II. Information Organization (description of the "Entity Set Model", a concept very close in spirit to the relational model) III. Data Representations and the Data Independent Assessing Model (DIAM) (based on the Entity Set Model, DIAM is a "complete model for the representing, storing, and retrieving of structured information".) The model is a four-level hierarchical one which the authors believe capable of describing the significant features of existing and proposed data-base systems in a consistent manner.

Senko, M.E., Lum, V.Y., Owens, P.J., "A File Organization Evaluation Model (FOREM)", Information Processing 68, 1969, North-Holland, Amsterdam.
[File System Design, Information System Modeling]

FOREM is a simulation program for a file management system. Given parameters describing logical and physical file layouts, search strategies, file content, and query types, the program generates search-time statistics.

Shemer, J.E., Collmeyer, A.J., "Database Sharing: A Study of Interference, Roadblock and Deadlock", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1972, pp. 141-163.
[Concurrent Use]

By simulating concurrent use of a shared database, the authors find that database sharing at the group level is not expected to result in any significant deadlock or interference problems.

Shneiderman, B., "A Model for Optimizing Indexed File Structures", Int. J. Comp. Inform. Sci. 3, 1974, pp. 93-103.
[Data Structures, File System Design]

Using a graph-theoretic model for data structure and access paths, Shneiderman discusses the minimization of search costs.

Shoshani, A., "Data Sharing in Computer Networks", NIC #12623, Oct. 1972.
[Concurrent Use, Data Sharing, Distributed System, Network]

The author presents several criteria by which to judge a distributed data management system, and then presents and analyzes five such systems. He concludes with some observations he has drawn based on his experience with implementing one of these systems.

Shoshani, A., Bernstein, A.J., "Synchronization in a Parallel-Accessed Data Base", CACM 12, Nov. 1969, pp. 604-607.
[Process Synchronization, Deadlock Prevention, Data Accessing, Data Sharing]

A data base is represented as a directed graph, and then the advatages and disadvantages of several algorithms for parallel access to the data base is discussed in terms of which situations can be handled, which can not, extra information required, and the length of time a node spends locked.

Shoshani, A., Spiegler, I., "The Integration of Data Management Systems on a Computer Network", NIC #15717, 1973.
[Distributed System, Data Accessing]

The authors present a rather extensive overview of the system they designed to act as a front end to several existing data management systems running at various sites on a network.

Sibley, E.H., Taylor, R.W., "A Data Definition and Mapping Language", CACM 16, Dec. 1973, pp. 750-759.
[Data Structures, Data Definition Language]

The authors propose that Data Definition Languages must be extended to provide a means of specifying the storage structure the data will be mapped onto. It is hoped that this will provide data independence.

Skinner, C.W., "A Heuristic Approach to Inductive Inference in Fact Retrieval Systems", CACM 17, 1974, pp. 707-712.
[Data Clustering]

The scheme here is to cluster very closely linked data (many properties in common). In this way examination of a typical cluster member or cluster centroid may be predictive of information about a given member-- even when such information is missing from the data base.

Slotnick, D.L., "Logic per Track Devices", Advances in Computers, 1970, pp. 291-296.
[Associative Processing]

A head per track disk is described in which each head is capable of boolean operations. This system could be used in applications with a large amount of data and little processing such as scanning the entire disk in one revolution for a match.

Snuggs, M.E., Popek, G.J., Peterson, R.J., "Data Base System Objectives as Design Constraints", Proc. ACM, 1974, pp. 641-647.
[Data Base Overview]

This paper is concerned with the problems of data independence, relatability, compatability, structural adaptability, integrity, recoverability, and security. The difficulty of these problems is discussed, as are some proposed solutions.

Snyderman, M., Hunt, B., "The Myriad Virtues of Text Compaction", Datamation, Dec. 1970, pp. 36-40.
[Data Compression]

The scheme here is to scan a text character by character, combining the most frequently used characters (A,E, etc.) with the one following to form a single coded character. The compression ratio is clearly less than 2 and tends to be about 1.5.

Sobolewski, J.S., "Programmable Communication Processors", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[Front-end Processor, User Support, Telecommunications]

This paper surveys the field of communication processors for inquiry and response systems, data collection, conversational computing, remote batch, and message switching systems. The role of minicomputer configurations is explored in each of these areas. The advantages and disadvantages of communication processors is discussed (the primary disadvantage being the lack of manufacturer supported software). This is a decent introductory paper.

Somia, M., "Synchronization Problems in a Computer Network", International Computing Symposium 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1974.
[Resource Sharing, Co-operating Processes, SOC (Systeme d'Ordinateurs Connectes), Process synchronization, Distributed System, Resource Allocation]

Synchronization problems connected with distributed resource allocation are discussed in relation to computer networks, in particular to SOC (Systeme d'Ordinateurs Connectes). The solution implemented is described, and advantages and disadvantages are discussed. Finally, the applicability in more general circumstances is studied.

Sorenson, P., "Interprocess Communication in Real Time Systems", Operating systems Review 7, Oct. 1973, ACM, pp. 1-7.
[Interprocess Communication, Message Switching, Data Sharing, Process Synchronization]

Some schemes developed for nonreal-time interprocess communication are reviewed and it is shown they are inadequate for real-time situations. Two models are presented which insure shared data integrity in a real-time situation. The first model involves the control of process scheduling, the second uses multiple copies of data sets. Finally, the notions of real-time independent and dependent data are discussed in reference to real-time communication.

Spier, M., Hastings, T., Cutler, D., "An Experimental Implementation of the Kernel/Domain Architecture", Operating Systems Review 7, Oct. 1973, ACM, pp. 8-21. [Domain, Domain Incarnation, Kernel, Protection]

The conceptual background and framework of a software simulated kernel/domain architecture is described. The need for storage class semantics, which do not exist in current high level languages, is explored. Functional implications, such as the design of a simple CPU scheduler, are given.

Spier, M., Organick, E., "The MULTICS Interprocess Communication Facility", Second ACM Symposium on Operating Systems Principles, October 1969, pp. 83-91. [Inter-process Communication, MULTICS, Co-operating Processes, Process Synchronization]

The MULTICS interprocess communication (IPC) facility is discussed as it relates to capabilities produced as a result of basic system design. Shared data bases by virtue of unambiguous file system names, lock and unlock primitives, and block/wakeup services for processor multiplexing are the basis for the IPC facility.

Spragins, J.D., "Analysis of Loop Transmission Systems", Second Symposium on Problems in the Optimization of Data Communication Systems, 1971, pp. 175-182. [Ring Network, Network Analysis, Queueing Theory]

A queueing theory analysis is performed on loop transmission systems with a single controller and random slot assignment with fixed slot size (the 'lazy suzan'). The paper discusses results of the research effort and emphasis the trade-off considerations in the design of loop systems (buffer size, terminal waiting lines, printer impact, etc.).

Stanfel, L.E., "Optimal Trees for a Class of Information Retrieval Problems", Inform. Stor. Retr. 9, 1973, pp. 43-59. [Data Structures, Data Trees]

This paper reanalyzes the optimal tree problem under the hypothesis that horizontal steps through the tree may be more costly than vertical ones. The analysis leads to an integer programming problem and an algorithm for its solution is given.

Stanfel, L.E., "Tree Structures for Optimal Searching", JACM 17, 1970, pp. 508-517.
[Data Structures, Data Trees]

This paper provides a discussion and critique of (Sussenguth, 1969) and also gives some preliminary results which makes it a useful introduction to (Stanfel, 1973).

Stocker, P.M., Dearnley, P.A., "Self-Organizing Data Management Systems", Computer J. 16, May 1973, pp. 110-115.
[Data Structuring, Data Reconfiguration, Automatic Data Structuring, Access Paths]

This paper proposes a system which examines queries to determine the least costly way to respond; included is the possibility of automatically setting up file copies sorted on different keys, partial file copies, etc. Statistical information may be saved for periodic restructuring.

Stonebraker, M., "The Choice of Partial Inversions and Combined Indices", Int. J. Comp. Inform. Sci. 3, 1974, pp. 167-188.
[Retrieval Strategies, File System Design, Data Structures]

By characterizing the storage medium and the query set, the author obtains analytic results concerning good indexing strategies. In particular the choice of attributes to be indexed in a partially inverted file and the choice of an optimal subset of comoined indices is obtained.

Su, S.Y., Copeland, G.P., Lipovski, G.J., "Retrieval Operations and Data Representations in a Context-Addressed Disc System", Proc. ACM SIGPLAN-SIGIR Interface Meeting, 1974, pp. 144-153.
[Associative Processing]

The advantages of logic per track discs are discussed. These include avoiding the multilevel mappings from high-level retrieval language to machine language and from user oriented data representation to machine oriented data representation.

Summerill, L.F., Kory, M., "Security in Data Management", Eighth Hawaii Int'l Conf. on System Sciences, 1975, pp. 191-194.
[Access Control, Data Security, Security]

This paper briefly discusses many of the various aspects that go into a secure system, ranging from building security guards to aspects of monitoring process activities. Contains some good, short definitions of key phrases.

Summers, R.C., Fernandez, E.B., Coleman, C.D., "Shared Data Access Control with Programming Language Support", Eighth Hawaii Int'l. Conf. on System Sciences, 1975, pp. 187-190.
[Access Control]

This paper describes a method of classifying users, application programs, data items, restrictions based on specific data items, etc., into groups, in a way such that access control can be implemented with only a few changes to a currently existing higher level programing language.

Sunshine, C., "Issues in Communication Protocol Design--Formal Correctness", InterNetwork Working Group Protocol Note #5, Oct. 1975.
[Protocol, Flow Control]

A formal description is given of the failure modes of a simple positive acknowledgement/retransmission protocol with and without sequencing.

Sussenguth, E.H.,Jr., "Use of tree Structures for Processing Files", CACM 6, 1963, pp. 272-279.
[Data Structures, Data Trees]

This is the classic paper describing tree-structured data and analyzing search and update efficiency.

Sutherland, I.E., "Computer Displays", Scientific American 222, June 1970, p. 57.
[Graphics, Applications]

A non-technical description of computer graphics, and a layman-oriented explanation of how graphics output works, and of several applications of graphics terminals is given. One hidden surface algorithm is given.

Teichroew, D., "An Approach to Research in File Organization", Proceedings of the ACM Symposium on Inform. Stor. and Retr., J. Minke and S. Rosenfeld, eds., 1971.
[File System Design, Information System Modeling]

The thesis of this paper is that research on file organization has not made much progress because the subject is so large and unstructured. The author suggests a structure--that of the Univ. of Michigan Information Systems and Optimization System (ISDOS) project--to be followed.

Thesen, A., "Scheduling of Computer Programs for Optimal Machine Utilization", BIT 13, 1973, pp. 206-216.
[Process Scheduling, Batch Operations, Operating System, Resource Allocation]

An algorithm which yields optimal use of a computer's resources taking into account CPU utilization, memory utilization, priorities, and proximity to deadlines is described. The algorithm is specified for a 360-like batch job environment.

Thomas, R., "A Model for Process Representation and Synthesis", Report #MAC-TR-87, Project MAC, MIT, June 1971.
[Process Representation, Process Synchronization]

The problem of representing groups of loosely connected processes is investigated and a model for process representation useful for synthesizing complex patterns of process behavior is developed. Concepts relevant to the process representation model are defined; a model for process representation is developed; it is shown that the model for process representation is a useful one for synthesizing process behavior patterns. It is suggested how the model could be used as a semantic base for a very potent language extension facility.

Thomas, R., "A Resource Sharing Executive for the ARPANET", BBN Report 2522, March 1973.
[Resource Sharing, User Support]

This describes the RSEXEC system developed for ARPANET TENEX's. The program allows inter-entity functions as described in Bressler's paper (see RFC 441), an environment for file transfer and mail, and maintenance of a list of accessed files.

Thomas, R., "Comments on the Common Command Language Effort", Personal paper to CCL Committee, 1974.
[User Support, Command Language, Network Command Language]

This paper discusses perceived problems with the proposals made in a predecessor of RFC 666. The paper considers the proposal from a different point of view shedding some light on questions such as machine readable versus human readable protocols, resource sharing, etc., and ends with a counter proposal.

Thomas, R., "On the Problem of Signature Authentication for Network Mail", RFC 644, July 1974.
[Mail, Access Cotrol, Security, Authentication]

This paper discusses one approach to the authentication of mail senders, i.e., is the mail from who it says it is. The approach relies on the assumption that local authentication is possible and then attempts to build the necessary capabilities on this.

Thompson, F.B., "English for the Computer", AFIPS 29, 1966, pp. 349-356.
[Natural Language]

It is the central thesis of the paper that, "when the subject matter of English is limited to material whose interrelationships are specifiable in a limited number of precisely structured categories, English becomes a formal language".

Thompson, F.B., Lockemann, P.C., Dostert, B., Deverill, R.S., "REL: A Rapidly Extensible Language System", Proc. ACM, 1969, pp. 399-414.
[Natural Language]

REL is a English language system which allows the user to extend the language to fit his particular needs. For the system to work efficiently, the user's data structures must reflect his conceptual organization of the data.

Trafton, P.J., Blank, H.A., McAllister, N.F., "Data Transmission Network Computer-to-Computer Study", Computer Sciences Corporation, Proc. Second Symposium on Problems in the Optimization of Data Communications Systems, Palo Alto, Califiornia, October 1971, pp. 183-191.
[Error Detection, Error Correction, Communications, Data Transmission]

An analysis of the general intercomputer communication problem is performed. The model contains a number of intermediate communication links with an intermediate satellite link. The general store-and-forward technique is considered with an Automatic Repeat Request (ARQ) discipline and a Forward Error Correction (FEC) coding technique. A comparison with empirical data indicates the model is correct. ARQ is shown to be favored if each link has separate error control while FEC is more viable with end-to-end error control.

Turoff, M., "PARTY-LINE and DISCUSSION Computerized Conference Systems", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[Teleconferencing]

This paper discusses two systems developed by the Office of Emergency Preparedness as adjuncts to their EMISARI information management system. An analysis of the cost and effectiveness of teleconferencing versus the face to face meeting is presented in good detail.

van Lamsweerde, A., "Deadlock Prevention in Real Time Systems", International Computing Symposium 1973, A Gunther, B. Levrat, H. Lipps, eds., North-Holland, 1974.
[Deadlock, Process Scheduling, Resource Allocation]

A deadlock prevention scheme that takes job completion times into account is given. The maximum claim and maximum execution of each job is assumed. A dynamic programming formulation is presented and its feasibility discussed.

van Rijsbergen, C.J., "Further Experiments With Hierarchic Clustering in Document Retrieval", Inform. Stor. Retr. 10, 1974, pp. 1-14.
[Clustering, Retrieval Strategies]

This is a continuation of the work of Jardine and Van Rijsbergen (1971). A more general search strategy (allowing for the retrieval of more than one cluster) is presented and tests on several document files are discussed.

van Rijsbergen, C.J., "An Algorithm for Information Structuring and Retrieval", Comp. J. 14, 1971, pp. 407-411.
[Data Clustering, Retrieval Strategies]

This is an article on document clustering which emphasizes the clustering algorithm. Use of single-linked hierarchical clusters with representatives arranged in a tree structure allows retrievals of various size clusters matching the query more or less well. "Moderate success" on a collection of 200 documents is reported.

Vold, H., Sjogren, B.H., "Optimal Backup of Data Bases", BIT 13, 1973, pp. 233-241.
[Data Base Recovery, Data Base Integrity]

Assuming that a data base is backed up by periodically dumping the data base to tape and maintaining a file of transactions which have taken place since the last dump, the authors present a mathematical criterion for determining the optimal interval for taking the dumps to minimize the cost of maintaining the data base at an operational level.

Volk, J.L., "Interactive Television Experiment in Reston, Virginia", Proc. IEEE COMPCON73, 1973, pp. 81-84.
[Communications]

A two-way CATV system operating in Reston, Va. was demonstrated by the MITRE Corporation. Services such as computer games, financial news, and educational materials were provided to the subscriber population. The subscribers used an ordinary television set with a refresh device (a commercial video recorder player) and a keyboard or touch-tone telephone as communications devices. A more economical approach is also described, and the economics of operation are discussed.

Wagner, R., "Indexing Design Considerations", IBM Syst. J. 12, 1973, pp. 351-367.
[Data Accessing, Data Structuring, Data Compression]

Although written in the context of the IBM Virtual Storage Access Method project, this paper is a good introduction to the design, maintenance, compression, etc. of indexes.

Wagner, R., "Common Phrases and Minimum-Space Text Storage", CACM 16, 1973, pp. 148-152.
[Data Compression]

This paper addresses the following problem: given an encoding of certain strings and a message containing these strings but with overlap, how is the message best encoded? The dynamic programming algorithm given here may be too unwieldy for large data sets.

Waldbaum, G., "Evaluating Computing System Changes by Means of Regression Models", Proc. First Annual SIGME Symposium, 1973, pp. 127-135.
[Measurement, Performance Evaluation, Regression]

This paper discusses how regression models can be applied to system evaluation. The model is applied to the evaluation of changes made to an APL system.

Walden, D., "A System for Interprocess Communication in a Resource-Sharing Computer Network", CACM 15, April 1972, pp. 221-230.
[Interprocess Communication, Ports, Message Switched Protocol]

A system of communication between processes based on messages is described and the communication system is extended so that it may be used between processes distributed throughout a computer network. the hypothetical application of the system to an existing network is discussed.

Watson, R.W., "Some Thoughts on System Design to Facilitate Resource Sharing", RFC 592, NIC 20391, Nov. 1973.
[Distributed System, Resource Sharing, ARPANET]

An appeal is made to system designers on ARPANET hosts to systemitize interfaces to system services. Decoupling the service from a direct link to the local operating system makes it more accessible to other sites located around the network.

Wax, D.W., "The ALOHA Radio Modulation Scheme", ARPA Network Packet Radio Temporary Note #17, NIC 13863, Jan. 1973.
[Packet Radio]

The RF modulation scheme used by the ALOHA Network is described. The history and hardware are described in some detail. The performance of the modulation method is briefly presented.

Weis, A., "Distributed Network Activity at IBM", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 1-25.
[RJE, Resource Sharing, TSS, Protocol, Centralized System, Distributed System, Security]

IBM experimental network activities, related to TSS, during 1968- 1972 are described. Some of the outstanding problems that will have to be addressed during the coming years in the area of computer networks are discussed.

Wells, M., "File Compression Using Variable Length Encoding", Comp. J. 15, Nov. 1972, pp. 308-313.
[Data Compression]

The compression technique discussed here is simply Huffman coding. Some consideration is given to implementation of encoding and decoding, and possible extensions (non-binary Huffman codes, self-synchronizing codes) are briefly mentioned.

White, J.E., "Response to Critiques of the Proposed Mail Protocol", RFC #555, July 1973.
[Mail, User Support]

This RFC provides a good look at the protocol designer's response to criticism of his design and how the protocol is changed to meet the criticism. More specifically, this RFC provides more discussion of the requirements of both use and implementation of the protocol.

White, J.E., "A Proposed Mail Protocol", RFC 524, June 1973.
[Mail, User Support]

This paper gives a detailed specification of a Mail Protocol for the ARPANET. The protocol provides many sophisticated functions such as forwarding, distribution control, clerking, etc. This paper is a must for any attempts at good on-line mail service.

Whitney, K.M., "Fourth Generation Data Management Systems", AFIPS 42, 1973, pp. 239-244.
[Content Addressing]

An overview of the evolution of data management systems and current trends is given. The author then presents the query language of an experimental relational data management system (RDMS), placing emphasis on the ease with which the non-programmer can formulate his requests.

Wilkes, M.V., "Automatic Load Adjustment in Time Sharing Systems", Proc. ACM Workshop on System Performance Evaluation, 1971, pp. 308-320.
[Measurement, Performance Evaluation, Load Measures]

This paper discusses how control theory techniques may be applied to dynamically control system load. Two algorithms are discussed. The first attempts to predict the number of tasks that can be admitted while maintaining control. The second adjusts the number of users such that the load is maintained. The paper considers the stability and oscillatory natures of the algorithms in some detail.

Wilkes, M.V., "Associative Tabular Data Structures", Symposium on Data Structures in Programming Languages, J.T. Tou and P. Wegner, eds., ACM, Feb. 1971.
[Data Structuring]

This paper suggests that structure can be imposed on tabular data by the inclusion of associative links and associative search--i.e. "the selection of rows by scanning columns for given symbols.".

Wilkes, M.V., "On Preserving the Integrity of Data Bases", Comp. J. 15, Aug. 1972, pp. 191-194.
[Data Base Integrity]

A survey of techniques to maintain the integrity of data bases is given. These techniques include incremental dumping and the keeping of journals.

Wilkov, R., "Design of Computer Networks Based on a New Reliability Measure", Computer Communications Networks and Teletraffic, J. Fox, ed., 1972, pp. 371-384.
[Network Design, Network Topology, Reliability]

A new criterion for measuring reliability of computer and communications networks based on regular graph theory is suggested. A heuristic iterative procedure, based on this criterion, is given for constructing a maximally reliable network with a specified number of nodes and communications links. Finally, reliabilities of several proposed ARPANET topologies are compared with reliabilities of corresponding topologies derived by the given procedure.

Winkler, A.J., "File Structure Determination", Proceedings ACM Symposium Inform. Stor. and Retr., J. Minker and S. Rosenfeld, eds., 1971.
[Data Structures, Data Accessing, Information System Modeling]

A methodology for the selection of an appropriate file structure in a specific situation is discussed. The idea is to develop an equation for retrieval time in terms of parameters describing data structure, retrieval algorithm, average properties of queries, etc.

Wirth, N., "From Programming Techniques to Programming Methods", International Computing Symposium 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1974, pp. 47-54.
[Structured Programming, Programming Methods, Modularity]

Brief examples are given of structured programs, which are programs formulated as a hierarchical, nested structure of statements. The relationship of structured programming to program verification, as well as the role of structured languages is discussed.

Wodon, P., "Still Another Tool for Synchronizing Processes", Dept. of CS, Carnegie-Mellon Univ., Aug. 1972.
[Process Synchronization, Concurrent Processes, Semaphore]

A synchronizing tool which for some applications is more convenient than the usual semaphore to obtain transparent programs and easy correctness proofs is outlined. The implementation of this new "semaphore" is briefly discussed.

Wolfendale, G.L., "A System for the Definition of the Syntax and Semantics of Data Definition Languages", International Computing Symposium 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1974, pp. 517-525.
[Data Description Lanuages]

A language system (DDL), which aims to provide a necessary and sufficient set of rules for the embodiment of any conceivable data description and management specification requirements, is described.

Wong, E., Chiang, T.C., "Canonical Structure in Attribute Based File Organization", CACM 14, 1971, pp. 593-597.
[Data Structuring, Clustering]

The idea here is to cluster the data into small, disjoint sets or "atoms", each atom being always retrieved as an entity. As the authors remark, it may happen that each record is an atom.

Wulf, W., Cohen, E., Corwin, W., Jones, A., Levin, R., Pierson, C., Pollack, F., "HYDRA: The Kernel of a Multiprocessor Operating System", CACM 17, June 1974, pp. 337-345.
[Operating System, Security, Resource Allocation, Centralized System]

This paper describes the operating system for the Carnegie-Mellon Multi-Mini-Processor. HYDRA is designed to facilitate experimentation, and design goals toward that end are described. The notions of resources, objects, and capabilities are described in detail, and an extended example is given.

Wulf, W.A., "Performance Monitors for Multi-Programming Systems", Proc. Second Symposium on Operating System Principles, Princeton, 1969, pp. 175-181.
[Measurement, Performance Evaluation]

This paper develops a collection of measures to evaluate total system performance, as well as corresponding per-process measures. The measures are intended for dynamic system tuning and job mix tuning. The measures are fairly rich and show some promise for applicability.

Wulf, W.A., Bell, C.G., "C.mmp--A Multi-Mini-Processor", AFIPS FJCC, 1972, pp. 765-777.
[Multi-processing, Process synchronization, Resource Sharing, Operating System, Computer Hardware]

This paper describes a multi-processor configuration of Digital Equipment Corporation PDP-11's being constructed at Carnegie-Mellon University. The processor, memory, and switches being used are described. An operating system kernel called HYDRA is introduced, and a very brief discussion of resources and protection is given. Processor synchronization and related software issues are discussed.

Yue, P.C., Wong, C.K., "Storage Cost Considerations in Secondary Index Selection", IBM Research Report RC 5070, October 1974.
[Data Structures, File Allocation, File System Design]

This paper combines the problem of choosing the best secondary indexes with the problem of best allocating the files to a memory hierarchy in an overall optimization analysis.

Yuen, M., Black, B., Newhall, E., Venetsanopoulos, A., "Traffic Flow in a Distributed Loop Switching System", Computer Communications Networks and Teletraffic, J. Fox, ed., 1972, pp. 29-46.
[Traffic Analysis, Message Switching, Distributed System, Ring Network]

An approximate analytical technique is outlined to calculate statistics for the traffic behavior of a distributed loop switching system under light traffic conditions. Simulation results were obtained from an IBM 370/165 for two separate models of traffic and flow. They agreed closely with those predicted by the statistical model. Finally, it is shown that the system can settle to a steady state even in the most adverse conditions.

Zimmerman, H., Elie, M., "Transport Protocol--Standard Host-Host Protocol for Heterogeneous Computer Networks", Reseau CYCLADES SCH519.1, June 1974.
[Host-Host Protocol, Flow Control, Error Recovery, Protocol]

This paper describes the host-host protocol for the French CYCLADE network. The protocol is significantly different than others in current use and is highly flexible.

Data Management Subtopics

1. Data Structures
2. Hashing
3. Clustering and Partitioning
4. Compression
5. Data Languages
6. Data Integrity
7. File Allocation

Anderson, R., Cerf, V., Harslem, E., Heafner, J., Madden, J., Metcalfe, R., Shoshani, A., White, J., Wood, D., "Status Report on Proposed Data Reconfiguration Service", RFC 138, NIC 6715, April 1971.
[Data Reconfiguration, Protocol]

One approach to providing specific data I/O format adaptation is for those sites with substantial computing power to offer a data reconfiguration service--a proposed example of such a service is described.

Anderson, R., Cerf, V., Harslem, E., Heafner, J., Madden, J., Metcalfe, R., Shoshani, A., White, J., Wood, D., "Data Reconfiguration Service--An Implementation Specification", RFC 166, NIC 6780, May 1971.
[Data Reconfiguration, Protocol, Language]

This paper gives the specifications of the Data Reconfiguration Service (DRS), which is a software mechanism to reformat Network data streams.

Arora, S.R., Dent, W.T., "Randomized Binary Search Technique", CACM 12, 1969, pp. 77-80.
[Data Structures, Data Trees]

A natural ordering of records is assumed and a tree structure is set up (based on the "greater than", "less than" binary choice) as the records are received in random order. A mathematical model for this process is set up and analyzed.

Artaud, A., Nicolas, J.M., "An Experimental Query System: Synton", International Computing Symposium, 1973, pp. 557-563.
[Data Structures]

A two level data management system is described. At the lower level, atoms and relations are used to define elementary information. At the upper level, axioms are used to define the data structure.

Ash, W.L., Sibley, E.H., "TRAMP: An Interpretive Associative Processor with Deductive Capability", Proc. ACM, 1968, pp. 143-156.
[Associative Processing]

An "associative memory" is used to facilitate operations on binary relations. A deductive system is implemented using the binary relations. Hash coding is used to implement the "associative memory".

Astrahan, M.M., Chamberlin, D.D., "Implementation of a Structured English Query Language", IBM Technical Report RJ 1464, 1974.
[Relational Data System, Query Language]

The implementation of a relational query language, SEQUEL, is described. It has been implemented using a prototype interpreter design to minimize accessing operations. The optimization algorithms are described.

Berman, G., Colijn, A.W. , "A Modified List Technique Allowing Binary Search", CACM 21, 1974, pp. 227-232.
[Data Structuring, Retrieval Strategies]

This paper proposes a modified linked-list structure, in which consecutive list elements are placed in a block of consecutive memory locations whenever possible. Binary searches may then be used on these blocks.

Berra, P.B., "Some Problems in Associative Processor Applications to Data Base Management", AFIPS Conf. Proceedings 43, 1974, pp. 1-5.
[Associative Memory]

This is a brief, up-to-date review of research into associative devices and their application to handling data bases.

Betourne, C., Boulenger, J., Ferrie, J., Kaiser, C., Kott, J., Krakowiak, S., Mossiere, J., "Process Management and Resource Sharing in the Multiaccess System 'ESOPE'", ACM Second Symposium on Operating Systems Principles, October 1969, pp. 67-74.
[Resource Sharing, Process Control, Process Synchronization, File System Design, Virtual Memory, Resource Allocation]

Process management, virtual memory, file system organization, memory allocation, and user scheduling are discussed generally in relation to the main design principles of the multiaccess system ESOPE. No actual implementation details are given.

Bjorner, D., Codd, E.F., Deckert, K.L., Traiger, I.L., "The GAMMA-0 n-ary Relational Data Base Interface Specifications of Objects and Operations", IBM Research Report RJ 1200, 1973.
[Relational Data System]

GAMMA-0, a low level interface for the manipulation of a relational data base is described. It is intended to be used as a base for implementing higher level interfaces.

Bloom, B.H., "Some Techniques and Tradeoffs Affecting Large Data Base Retrieval Times", Proceedings ACM Twenty Fourth National Conf., 1969, pp. 83-95.
[Data Structuring, File System Design, Retrieval Strategies]

An analysis of retrieval-time savings from the use of inverted files is given. The corresponding increase in update time and the further savings that may be accomplished by compression of the inverted file are also discussed.

Bobrow, R., "An Experimental Data Management System", Data Base Systems, R. Rustin, ed., Prentice-Hall, 1972, pp. 125-141.
[Data Structures]

It is shown that a relational structure is inherent in EDMS (Experimental Data Management System) even though it uses the object-oriented network viewpoint and not a true relational point of view. The network viewpoint is convenient for expressing certain implementation strategies, and restrictions on the permissible network structures allow efficient search strategies. The relational point of view makes it possible to express a large number of queries in a uniform language.

Boyce, R.F., Chamberlin, D.D., Hammer, M.M., King, W.F., "Specifying Queries as Relational Expressions", Proc. ACM SIGPLAN-SIGIR Interface Meeting, 1975, pp. 31-38.
[Query Languages, Relational Theory]

The authors present SQUARE, a set oriented data sublanguage. SQUARE attempts to mimic how people use tables to obtain iformation.

Bracchi, G., Fedeli, A., Paolini, A., "A Language for a Relational Data Base Management System", Proc. Sixth Annual Princeton Conf. on Information Sciences and Systems, 1972, pp. 84-92.
[Relational Query Language]

This paper illustrates COLARD, which is a non-procedural language for defining, creating, maintaining, updating and querying a relational data base, which is viewed as a collection of time-varying relations of assorted degrees. The generalized set theoretical operators for manipulating hierarchical relations are discussed. Language statements refer only to the user's logical data representation and are independent of underlying data base management system technology.

Casey, R.G., "Design of Tree Structures for Efficient Querying", CACM 16, 1973, pp. 549-556.
[Data Structuring, Data Partitioning, Data Trees, Search Trees, Data Clustering]

An algorithm for designing a near-optimal tree structure for data is given. Optimality is defined in terms of total minimum search-path length for a given set of queries. Some pre-clustering of the data (using information on which records are retrieved together) is suggested to make the approach more practical for large files.

Chamberlin, D.D., Boyce, R.F., "SEQUEL: A Structured English Query Language", IBM Research Report RJ 1394, 1974.
[Relational Query Language]

A structured English query language for accessing a relational data base is presented. Queries are formulated as set-oriented table look-ups rather than selecting a row at a time.

Chien, R.T., Mark, E.A., "A Document Storage Method Based on Polarized Distance", JACM 21, 1974, pp. 233-245.
[File Allocation, Clustering, Retrieval Strategies]

Documents are clustered according to "weight" or number of non-zero terms in their binary index vectors. Theorems are developed to determine which clusters should be searched for a given query. A brief analysis compares the method with linear and inverted filing schemes.

Childs, D.L., "Feasibility of a Set-Theoretic Data Structure", IFIP Congress 68, 1968, pp. 420-430.
[Set Theoretic Data Structures]

Many problems dealing with arbitrarily related data can be expedited on a digital computer by a storage structure which allows rapid execution of operations within and between sets of datum names. The structure should be general enough that the sets involved may be unrestricted, and the set of operations should be general in nature. These problems are resolved in this paper by the introduction of the "complex" concept which also allows natural extension of properties of binary relations to properties of general relations.

Childs, D.L., "Description of a Set-Theoretic Data Structure", AFIPS FJCC, 1968, pp. 557-564.
[Set Theoretic Data Structures]

Data which are not intrinsically related have to be expressed (stored) in such a way as to define the way in which they are related before any data structure is applicable. Since any relation can be expressed in set theory as a set of ordered pairs, and since set theory provides a wealth of operations for dealing with relations, a set-theoretic data structure appears reasonable.

Codd, E.F., "A Relational Model of Data for Large Shared Data Banks", CACM 13, June 1970, pp. 377-387.
[Relational Theory]

The author proposes the relational model of data for use in data banks. It is hoped that this model will provide a simple and complete view of data usable by a large community of users.

Codd, E.F., "Further Normalization of the Data Base Relational Model", Data Base Sysems, R. Rustin, ed., Prentice-Hall, 1972, pp. 125-141.
[Relational Theory]

Simplifications are proposed for the relational model which will remove certain update anomalies and provide a more consistent view.

Codd, E.F., "Normalized Data Base Structure: A Brief Tutorial", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 1-17.
[Relational Structures]

This tutorial discusses the relational view of data and techniques to simplify data base relations by normalization.

Codd, E.F., "Seven Steps to Rendezvous with the Casual User", Proc. IFIP TC-2 Working Conference on Data Base Management Systems, 1974.
[Query Languages, Relational Theory]

The underlying concepts of a natural English query language are described. It is assumed that the user will not correctly state his query on his first attempt and it is the responsibility of the system to help him rephrase the query.

Codd, E.F., "Recent Investigations in Relational Data Base Systems", IBM Research Report RJ 1385, April 1974.
[Relational Theory]

An overview of the relational approach to data management is presented. Included in the overview are recent advances in relational theory, and areas which require investigation.

Coffman, E.G.,Jr., Eve, J., "File Structures Using Hashing Functions", CACM 13, 1970, pp. 427-432, 436.
[Data Structures, Data Trees]

This paper suggests that keys be transformed through a hashing function into binary strings, following which the strings may be used in the usual ways to generate binary-tree structured data.

Collmeyer, A., Sherner, J., "Analysis of Retrieval Performance for Selected File Organization Techniques", AFIPS 37, pp. 201-210.
[Retrieval Strategies, Data Structures]

Models for three basic types of indexing--spatial, tabular, and calculated-- are developed and analyzed.

Coulouris, G., Evans, J., Mitchell, R., "Toward Content Addressing in Data Bases", Comp. J. 15, May 1972, pp. 95-98.

[Content Addressing]

A data base is required to hold two classes of information: values, and relations between values. A "content addressed" system in which records are specified by the properties of the data items they contain is proposed. The characteristics and performance of existing data base management systems are discussed and evaluated, and some benefits to be expected from hardware-aided content-addressing systems are identified. An approach to the design of a hardware-aided content-addressed file system is proposed.

Crouch, D.B., "A Process for Reducing Cluster Representations and Retrieval Costs", Proc. ACM 1973, pp. 224-227.
[Data Clustering, Retrieval Strategies]

This is another paper on the technique of clustering documents for retrieval by cluster representative. (cf. Jardine and van Rijsbergen, 1971). This paper addresses the problem of compressng the cluster "representatives" in order to reduce storage and search costs. The author claims effective retrieval after ninety per cent compression.

Date, C., Hopewell, P., "Storage Structure and Physical Data Independence", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 139-168.
[Relational Data Structures]

The results of an investigation into the feasibility of physical data independence in a data base system are presented. The question, "Given a third normal form data picture, to what extent may the storage structure change?", is answered by first defining and explaining a number of concepts and using these concepts to illustrate some possible storage structures for a sample data base.

Date, C.J., Hopewell, P., "File Definition and Logical Data Independence", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 117-138.
[Data Independence]

An interface between applications program and data base which provides for logical and physical data independence is described. The minimum requirements for a language that manipulates this interface are given.

Dearnley, P., "A Model of a Self-Organizing Data Management System", Comp. J. 17, Jan. 1974, pp. 13-16.
[Data Structuring, Data Reconfiguration, Automatic Data Structuring]

This follows up on the ideas in Stocker and Dearnley (1973), giving some details on implementation and reporting on an actual test.

Dearnley, P.A., "The Operation of a Model Self-Organizing Data Management System", Computer J. 17, 1974, pp. 205-210.
[Data Structuring, Data Reconfiguration, Automatic Data Structuring]

This paper, a continuation of earlier work, reports on more extensive trials of the system, including cost analyses.

DeFiore, C.R., Stillman, N.J., Berra, P., "Associative Techniques in the Solution of Data Management Problems", Proc. ACM, 1971, pp. 28-36.
[Relational Data System, Content Addressing]

This paper is concerned with the development of data management systems from an associative point of view. The design utilizes relational set theory applied to information systems. The basic notion involves the mathematical transformation of hierarchical structures of n-ary relations into associative normal form (ANF). This transformation preserves the information content while at the same time allowing the information to be manipulated by an associative memory in a more efficient manner than is possible on a random access memory.

Dennis, J.B., "On the Exchange of Data", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1970, pp. 41-66.
[Data Definition Language, Data Structures]

This paper addresses the problem of moving data between computer installations, which may differ in their hardware, software, or program libraries and data files.

Earley, J., "Toward an Understanding of Data Structures", CACM 14, 1971, pp. 617-627.
[Data Structures, Access Paths]

This paper describes a formalism for describing both data structures and their implementation, in the sense that access paths are explicitly represented in the formalism. The work is preliminary; an elaborate mathematical construct is only hinted at and many problems for further study are given.

Elias, P., "Efficient Storage and Retrieval by Content and Address of Static Files", JACM 21, 1974, pp. 246-260.
[Retrieval Strategies]

This is a highly theoretical paper dealing with a file of fixed-length binary words and simple query types. Lower bounds on measures of bits stored and bits accessed per query are given and algorithms approaching those bounds are presented.

Engles, R.W., "A Tutorial on Data Base Organization", Annual Review in Automatic Programming, Vol. 7 Part I, 1972, pp. 1-64.
[File System Design, Data Independence, Data Structuring]

The first section of the report is an introduction, which includes data management history, trends, and terminology; the second section presents a theory of operational data based on the notions of entity sets and data maps; the third section is an exposition of data base design, emphasizing structure, search, and maintenance; the fourth section shows why data independence is a necessary feature of a viable data base system.

Engles, R.W., "An Analysis of the April 1971 Data Base Task Group Report", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 69-91.
[Data Structures, Data Definition Language, Data Manipulation Language]

The strengths and weaknesses of the DBTG report are discussed. Suggestions are then presented for some of its problems.

Farber, D.J., "The Structure of a Distributed Computer System--The Distributed File System", First Int'l Conf. on Computer Communications, Oct. 1972, pp. 364-370.
[Distributed System, File System Design, Network, DCS]

The DCS is a distributed computer system in which resource allocation is handled by the processes bartering with one another directly rather than through a central processor. This paper discusses the file system on the DCS, which has properties such that losing any processor does not affect any files not stored on that processor, and moving a file from one processor to another in no way affects the user's view of how to access the file.

Feldman, J.A., Rovner, P.D., "An Algol-Based Associative Language", CACM 12, Aug. 1969, pp. 439-449.
[Content Addressing]

A language in which items are addressed by partial content instead of address is described. Until associative memories become economically feasible, the data structures are implemented using hashing techniques.

Finkel, R.A., Bentley, J.L., "Quad Trees: A Data Structure for Retrieval on Composite Keys", Acta Informatica 3, 1974, pp. 1-9.
[Data Structures, Retrieval Strategies]

Data are often structured into a binary tree on the basis of the ordered values of one key. A "quad tree" is an analogous structure based on the values of two keys.

Frank, R.L., Yamaguchi, K., "A Model for a Generalized Data Access Method", AFIPS Conference Proceedings 43, 1974, pp. 45-52.
[Data Accessing, Information System Modeling]

This is a preliminary plan for a general information system model. The scheme is to have a set of data-independent access algorithms, driven by a high level language in which access methods may be described. Methods may then be tested, evaluated, and compared by simulation.

Goldstein, R.C., Strnad, A.J., "The MacAIMS Data Management System", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1970, pp. 201-229.
[Relational Data System]

MacAIMS is a relational data management system in which the user need not know how the data is represented.

Gotlieb, C.C., Tompa, F.W., "Choosing a Storage Schema", Acta Informatica 3, 1974, pp. 297-319.
[Data Structures]

This paper contains a useful listing of storage structures (including definitions and diagrams) as well as a description of a facility for evaluating relative costs of the schema.

Hawryszkiewych, I.T., Dennis, J.B., "An Approach to Proving the Correctness of Data Base Operations", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1972, pp. 323-348.
[Relational Data System, Integrity]

The authors present an abstract model of a relational data base and primitive operations on this model which allow sharing of data and concurrent use of the data base.

Heath, I., "Unacceptable File Operations in a Relational Data Base", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 19-34.
[Relational Structures, Data Integrity]

This paper is written within the context of a relational data base model as presented by E.F. Codd in "A Relational Model of Data for Large Shared Data Banks" and serves as a companion paper to his paper "Further Normalization of the Data Base Relational Model". The central thesis is that a file operation should not produce unexpected "side effects" in order to maintain a restriction (such as one-one, or many-one) on the file.

Hsiao, D., Harary, F., "A Formal System For Information Retrieval From Files", CACM 13, 1970, pp. 67-73.
[Data Structuring, Information System Modeling, Retrieval Strategies]

This paper presents a generalized file structure which encompasses inverted, index-sequential, and multilist files, as special cases. An accompanying general retrieval algorithm is described in some detail.

Hsiao, D.K., "A Generalized Record Organization", IEEE Transactions on Computers, C-20, 1971, pp. 1490-1495.
[File System Design, Data Structures]

Working in the context of an example, the author discusses such concepts as field level, occurrence and repetition of an attribute, type and size of values, and keywords, linkages and pointers. He distills from this discussion parameters characterizing records and overall record organization.

Huang, J.C., "A Note on Information Storage and Retrieval", CACM 16, 1973, pp. 406-410.
[Data Structuring, Data Trees, Automatic Data Structuring]

An algorithm is given for constructing a data tree (or, more generally, a network) from a given set of data and binary relations among the data keys or identifiers.

Jardine, N., van Rijsbergen, C.J., "The Use of Hierarchic Clustering in Information Retrieval", Inform. Stor. Retr. 7, 1971, pp. 217-240.
[Data Clustering, Retrieval Strategies]

The setting is document retrieval, where retrieval of all relevant items is not expected. The idea is to cluster the documents, match requests against various cluster "representatives", and return the best-matching cluster. Limited testing was done on a file of 200 documents.

Jervis, B., Parker, J.L., "An Approach for a Working Relational Data System", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1972, pp. 125-145.
[Relational Data System]

A data management system in which the user views his data as if it were in the relational form is described. It is not necessary that the data's physical structure be in the relational form.

Lefkovitz, D., "File Structures for On-line Systems", Spartan Books, 1969.
[File System Design, Retrieval Strategies]

This is a basic text on information systems. It includes chapters on directory decoding, file organization, file update and maintenance, etc.

Linde, R.R., Gates, R., Peng, T., "Associative Processor Applications to Real Time Data Management", AFIPS 42, 1973, pp. 187-195.
[Associative Processing]

This paper evaluates the comparative advantages of associative processing over conventional sequential processing as applied to data management functions and in particular the data management functions of the U.S. Air Force Tactical Air Control Center.

Lorie, R.A., Symonds, A.J., "A Relational Access Method for Interactive Applications", Data Base Systems, R. Rustin, ed., Prentice-Hall, 1972.
[Relational Data System, Data Languages]

This paper describes an experimental system that demonstrates interactive problem solving. The system is designed to meet the language and data base requirements of problem-solving. The components of the system are: a relational access method and an APL interpreter that provides the terminal user with the full facilities of APL/360. The data representation for a communications network design problem is discussed as an example.

Lum, V.Y., "Multi-attribute Retrieval With Combined Indexes", CACM 13, 1970, pp. 660-665.
[Data Accessing, Retrieval Strategies]

This paper generalizes the standard inverted file index scheme by proposing "compound" indices, in which records are indexed by an n-tuple of attribute values.

Madnick, S.E., Alsop, J.W., "A Modular Approach to File System Design", AFIPS SJCC, 1969, pp. 1-13.
[File System Design]

This paper presents a general model for file system design based on hierarchical "modules" or successive layers of software between user and physical data. The authors note that such modular design should be particularly useful in a network.

McCuskey, W., "On Automatic Design of Data Organization", AFIPS FJCC 1970, pp. 187-199.
[Set Theoretic Data Structures, Automatic Data Structuring]

This is largely a concepts paper, providing complicated terminology and descriptions for rather simple ideas. No solid results are given.

Moulder, R., "An Implementation of a Data Management System on an Associative Processor", AFIPS 42, 1973, pp. 171-176.
[Associative Processing]

An experimental data management system using an associative processor (AP) is discussed. The database resides on a parallel-head-per-track disk connected to the AP via 72 parallel channels.

Mullin, J.K., "The Specification of Data Structures, Access Methods, and Efficiency ", Proceedings Sixth Annual Princeton Conference on Information Sciences and Systems, 1972, pp. 79-84.
[File System Design, Access Paths, Information System Modeling]

This paper describes a file system simulation program: given information on the data and its structure, as well as retrieval mechanisms and basic costs, retrieval "activities" are simulated and activity costs generated.

Neuhold, E.J., "Data Mapping: A Formal Hierarchical and Relational View", Sixth Courant Computer Science Symposium, 1971.
[Data Structures]

A formal description of hierarchical and relational views of data is given. It is then shown that the two different structures have very close interrelations. This facilitates the definition of formal mapping between the two.

Page, E.S., Wilson, L.B., "Information Representation and Manipulation in a Computer", Cambridge Univ. Press, 1973.
[Data Structuring, Data Trees, Hashing]

This book is an excellent elementary introduction to the basics of computer information handling.

Parhami, B., "A Highly Parallel Computing System for Information Retrieval", AFIPS FJCC 41, 1972, pp. 681-690.
[Associative Processing]

A rotating associative processor, RAPID, is described. Design criteria are given along with logic diagrams.

Parhami, B., "Associative Memories and Processors: An Overview and Selected Bibliography", Proc. IEEE 61, June 1973, pp. 722-730.
[Associative Processing]

An overview of hardware and software techniques used with associative memories is given. There are 171 references.

Patt, Y.N., "Variable Length Tree Structures Having Minimum Average Search Time", CACM 12, 1969, pp. 72-76.
[Data Structures, Data Trees]

This paper contains two types of theorems on tree structures: One type dealing with optimal search orders for completely specified trees, and one dealing with construction of trees having minimum average search lengths if only the total number of leaves is specified.

Popek, G.J., Kline, C.S., "Verifiable Protection Systems", To be presented at the ACM/IEEE Software Reliability Conference in LA, CA., Apr. 1975.
[File System Design, Kernel, Access Control, Data Security, Privacy, Protection, Security, Co-operating Processes, Multi-programming]

This paper primarily describes the UCLA/VM project at UCLA. UCLA/VM is a PDP 11/45-based virtual machine kernel that is verifiable, secure, and a virtualizing package that creates virtual PDP 11/45's.

Rotwitt, T.,Jr., deMaine, P.A., "Storage Optimization of Tree Structured Files Representing Descriptor Sets", Proceedings 1971 ACM SIGFIDET Workshop, E.F. Codd and A.L. Dean, eds., pp. 207-217.
[Data Structures, Data Trees]

Files may be naturally structured into trees on the basis of the values taken on for the various attributes (keys). The number of nodes in the tree will vary according to which key is assigned to which level. This paper addresses the problem of determining an optimal arrangement.

Schwartz, J.T., "Abstract and Concrete Problems in the Theory of Files", Data Base Systems, R. Rustin, ed., Prectice-Hall, 1972, pp. 1-21.
[Data Structuring, Data Accessing, Retrieval Strategies, File System Design]

In this symposium talk given in May, 1971, Schwartz outlined the key problems that should be addressed in developing the area of data base management.

Senko, M.E., "Details of a Scientific Approach to Information Systems", Data Base Systems, R. Rustin, ed., Prentice-Hall, 1972, pp. 143-174.
[Information System Modeling, Information System Measurement, File System Design]

This 1971 Symposium talk is a good, readable introduction to information system modeling in general and Senko's FOREM in particular. (See other papers by Senko et al.)

Senko, M.E., Altman, E.B., Astrahan, M.M., Fehder, P.L., "Data Structures and Accessing in Data-Base Systems", IBM Systems Journal 12, 1973, pp. 30-93.
[Data Structuring, Data Accessing, Information System Modeling.]

This paper is in three parts: I. Evolution of Information Systems (an overview of the development and problems of data-base systems) II. Information Organization (description of the "Entity Set Model", a concept very close in spirit to the relational model) III. Data Representations and the Data Independent Assessing Model (DIAM) (based on the Entity Set Model, DIAM is a "complete model for the representing, storing, and retrieving of structured information".) The model is a four-level hierarchical one which the authors believe capable of describing the significant features of existing and proposed data-base systems in a consistent manner.

Senko, M.E., Lum, V.Y., Owens, P.J., "A File Organization Evaluation Model (FOREM)", Information Processing 68, 1969, North-Holland, Amsterdam.
[File System Design, Information System Modeling]

FOREM is a simulation program for a file management system. Given parameters describing logical and physical file layouts, search strategies, file content, and query types, the program generates search-time statistics.

Shneiderman, B., "A Model for Optimizing Indexed File Structures", Int. J. Comp. Inform. Sci. 3, 1974, pp. 93-103.
[Data Structures, File System Design]

Using a graph-theoretic model for data structure and access paths, Shneiderman discusses the minimization of search costs.

Sibley, E.H., Taylor, R.W., "A Data Definition and Mapping Language", CACM 16, Dec. 1973, pp. 750-759.
[Data Structures, Data Definition Language]

The authors propose that Data Definition Languages must be extended to provide a means of specifying the storage structure the data will be mapped onto. It is hoped that this will provide data independence.

Slotnick, D.L., "Logic per Track Devices", Advances in Computers, 1970, pp. 291-296.
[Associative Processing]

A head per track disk is described in which each head is capable of boolean operations. This system could be used in applications with a large amount of data and little processing such as scanning the entire disk in one revolution for a match.

Stanfel, L.E., "Optimal Trees for a Class of Information Retrieval Problems", Inform. Stor. Retr. 9, 1973, pp. 43-59.

[Data Structures, Data Trees]

This paper reanalyzes the optimal tree problem under the hypothesis that horizontal steps through the tree may be more costly than vertical ones. The analysis leads to an integer programming problem and an algorithm for its solution is given.

Stanfel, L.E., "Tree Structures for Optimal Searching", JACM 17, 1970, pp. 508-517.
[Data Structures, Data Trees]

This paper provides a discussion and critique of (Sussenguth, 1969) and also gives some preliminary results which makes it a useful introduction to (Stanfel, 1973).

Stocker, P.M., Dearnley, P.A., "Self-Organizing Data Management Systems", Computer J. 16, May 1973, pp. 110-115.
[Data Structuring, Data Reconfiguration, Automatic Data Structuring, Access Paths]

This paper proposes a system which examines queries to determine the least costly way to respond; included is the possibility of automatically setting up file copies sorted on different keys, partial file copies, etc. Statistical information may be saved for periodic restructuring.

Stonebraker, M., "The Choice of Partial Inversions and Combined Indices", Int. J. Comp. Inform. Sci. 3, 1974, pp. 167-188.
[Retrieval Strategies, File System Design, Data Structures]

By characterizing the storage medium and the query set, the author obtains analytic results concerning good indexing strategies. In particular the choice of attributes to be indexed in a partially inverted file and the choice of an optimal subset of combined indices is obtained.

Su, S.Y., Copeland, G.P., Lipovski, G.J., "Retrieval Operations and Data Representations in a Context-Addressed Disc System", Proc. ACM SIGPLAN-SIGIR Interface Meeting, 1974, pp. 144-153.
[Associative Processing]

The advantages of logic per track discs are discussed. These include avoiding the multilevel mappings from high-level retrieval language to machine language and from user oriented data representation to machine oriented data representation.

Sussenguth, E.H.,Jr., "Use of tree Structures for Processing Files", CACM 6, 1963, pp. 272-279.
[Data Structures, Data Trees]

This is the classic paper describing tree-structured data and analyzing search and update efficiency.

Teichroew, D., "An Approach to Research in File Organization", Proceedings of the ACM Symposium on Inform. Stor. and Retr., J. Minke and S. Rosenfeld, eds., 1971.
[File System Design, Information System Modeling]

The thesis of this paper is that research on file organization has not made much progress because the subject is so large and unstructured. The author suggests a structure--that of the Univ. of Michigan Information Systems and Optimization System (ISDOS) project--to be followed.

van Rijsbergen, C.J., "Further Experiments With Hierarchic Clustering in Document Retrieval", Inform. Stor. Retr. 10, 1974, pp. 1-14.
[Clustering, Retrieval Strategies]

This is a continuation of the work of Jardine and Van Rijsbergen (1971). A more general search strategy (allowing for the retrieval of more than one cluster) is presented and tests on several document files are discussed.

van Rijsbergen, C.J., "An Algorithm for Information Structuring and Retrieval", Comp. J. 14, 1971, pp. 407-411.
[Data Clustering, Retrieval Strategies]

This is an article on document clustering which emphasizes the clustering algorithm. Use of single-linked hierarchical clusters with representatives arranged in a tree structure allows retrievals of various size clusters matching the query more or less well. "Moderate success" on a collection of 200 documents is reported.

Whitney, K.M., "Fourth Generation Data Management Systems", AFIPS 42, 1973, pp. 239-244.
[Content Addressing]

An overview of the evolution of data management systems and current trends is given. The author then presents the query language of an experimental relational data management system (RDMS), placing emphasis on the ease with which the non-programmer can formulate his requests.

Winkler, A.J., "File Structure Determination", Proceedings ACM Symposium Inform. Stor. and Retr., J. Minker and S. Rosenfeld, eds., 1971.
[Data Structures, Data Accessing, Information System Modeling]

A methodology for the selection of an appropriate file structure in a specific situation is discussed. The idea is to develop an equation for retrieval time in terms of parameters describing data structure, retrieval algorithm, average properties of queries, etc.

Yue, P.C., Wong, C.K., "Storage Cost Considerations in Secondary Index Selection", IBM Research Report RC 5070, October 1974.

[Data Structures, File Allocation, File System Design]

This paper combines the problem of choosing the best secondary indexes with the problem of best allocating the files to a memory hierarchy in an overall optimization analysis.

Bell, J.R., "The Quadratic Quotient Method: A Hash Code Eliminating Secondary Clustering", CACM 13, 1970, pp. 107-109.
[Hashing]

This paper discusses the secondary clustering which occurs in the quadratic hash method and shows how it may be eliminated by modifying the method. Both analytical and empirical comparisons are made with other methods.

Bell, J.R., Kaman, C.H., "The Linear Quotient Hash Code", CACM 13, 1970, pp. 675-677.
[Hashing]

This paper presents a new algorithm for handling hashing collisions as well as computing the original hash address. The algorithm seems to be simple and efficient and appears to perform well in simulation tests. Clustering is not discussed.

Hopgood, F.R.A., Davenport, J., "The Quadratic Hash Method When the Table Size is a Power of 2", Computer J. 15, 1972, pp. 314-315.
[Hashing]

This is a brief, readable discussion of quadratic hashing, with an analysis showing that it may be even more effective than had previously been thought.

Lum, V.Y., "General Performance Analysis of Key-to-Address Transformation Methods Using an Abstract File Concept", CACM 16, 1973, pp. 603-612.
[Hashing]

This paper presents a theoretical method for analyzing and predicting the performance of hashing functions. The idea is to define a key "space" (consisting of all possible keys of a given form) and study the properties of the hashing function as a transformation on that space.

Lum, V.Y., Yuen, P.S.T., "Additional Results on Key-To-Address Transform Techniques: A Fundamental Performance Study on Large Existing Formatted Files", CACM 15, 1972, pp. 996-997.

[Hashing]

An addendum to Lum et al. (1971).

Lum, V.Y., Yuen, P.S.T., Dodd, M., "Key-To-Address Transform Techniques: A Fundamental Performance Study on Large Existing Formatted Files", CACM 14, 1971, pp. 228-239.
[Hashing]

This paper contains a careful study of eight different hash coding methods. The aim is to provide guidance as to which technique provides a most nearly uniform distribution of storage addresses in a given practical situation. See also Lum and Yuen (1972).

Morris, R., "Scatter Storage Techniques", CACM 11, 1968, pp. 38-43.
[Hashing]

This is a good review of the early work on hashing.

Nishihara, S., Hiroshi, H., "A Full Table Quadratic Search Method Eliminating Secondary Clustering", Int. J. Comp. Inform. Sci. 3, 1974, pp. 123-128.
[Hashing]

This paper describes a variation on quadratic hashing which searches the whole memory, eliminates secondary clustering, and requires no division operation.

Page, F.S., Wilson, L.B., "Information Representation and Manipulation in a Computer", Cambridge Univ. Press, 1973.
[Data Structuring, Data Trees, Hashing]

This book is an excellent elementary introduction to the basics of computer information handling.

Rothnie, J.B.,Jr., Lozano, T., "Attribute Based File Organization in a Paged Memory Environment", CACM 17, 1974, pp. 63-69.
[Hashing, Data Clustering, Data Structuring]

This paper suggests the computation of hash addresses ("pages" instead of single locations) as a function of several keys. This not only reduces search time (or the need for inverted files) but also clusters the data conveniently.

Anderberg, M.R., "Cluster Analysis for Applications", Academic Press, 1973.
[Data Clustering, Data Partitioning]

This book serves as a good introduction and guide to the literatuure of clustering techniques--linked, hierarchical, etc. Because of the enormous size of the clustering literature, this bibliography will otherwise omit work not directly dealing with data base applications.

Casey, R.G., "Design of Tree Structures for Efficient Querying", CACM 16, 1973, pp. 549-556.
[Data Structuring, Data Partitioning, Data Trees, Search Trees, Data Clustering]

An algorithm for designing a near-optimal tree structure for data is given. Optimality is defined in terms of total minimum search-path length for a given set of queries. Some pre-clustering of the data (using information on which records are retrieved together) is suggested to make the approach more practical for large files.

Chien, R.T., Mark, E.A., "A Document Storage Method Based on Polarized Distance", JACM 21, 1974, pp. 233-245.
[File Allocation, Clustering, Retrieval Strategies]

Documents are clustered according to "weight" or number of non-zero terms in their binary index vectors. Theorems are developed to determine which clusters should be searched for a given query. A brief analysis compares the method with linear and inverted filing schemes.

Crouch, D.B., "A Process for Reducing Cluster Representations and Retrieval Costs", Proc. ACM 1973, pp. 224-227.
[Data Clustering, Retrieval Strategies]

This is another paper on the technique of clustering documents for retrieval by cluster representative. (cf. Jardine and van Rijsbergen, 1971). This paper addresses the problem of compressng the cluster "representatives" in order to reduce storage and search costs. The author claims effective retrieval after ninety per cent compression.

Ghosh, S.P., "File Organization: The Consecutive Retrieval Property", CACM 15, Sept. 1972, pp. 802-808.
[Data Clustering]

For a linear storage medium, it would be nice if all records retrieved by any one query were stored in consecutive locations and without redundancies. The possibility of so ordering a file (for a given query set) is studied in this paper. Clearly this possibility is remote for an extensive query set but may occur for important subsets.

Gorenstein, S., Galati, G., "Data Base Reorganization for a Storage Hierarchy", IBM Research Report RC 5063, October 1974.
[Data Clustering, Storage Management, Storage Hierarchies]

This paper suggests clustering together data which is likely to be retrieved together. The clusters then become blocks to be transferred between storage levels. A novel feature is the development of a replacement rule to determine which cluster in higher-level storage is to be replaced.

Jardine, N., van Rijsbergen, C.J., "The Use of Hierarchic Clustering in Information Retrieval", Inform. Stor. Retr. 7, 1971, pp. 217-240.
[Data Clustering, Retrieval Strategies]

The setting is document retrieval, where retrieval of all relevant items is not expected. The idea is to cluster the documents, match requests against various cluster "representatives", and return the best-matching cluster. Limited testing was done on a file of 200 documents.

Ramamoorthy, C.V., Chin, Y., "An Efficient Organization of Large Frequency-Dependent Files for Binary Searching", IEEE Trans. Comp. C-20, 1971, pp. 1178-1187.
[File Partitioning]

The basic idea here is to partition the file into blocks of 2**j-1 items (for efficient binary search), all items in a block expected to be accessed with similar frequencies. The scheme is most appropriate to single item searches.

Rettenmayer, J.W., "File Ordering and Retrieval Cost", Inform. Stor. Retr. 8, 1972, pp. 79-93.
[Data Clustering]

This paper proposes that for efficient retrieval data should be clustered according to similarity of keys, and members of clusters should be stored together. Unlike document retrieval, where only the cluster representatives (or centroids) are examined for similarity to a query, here the centroids provide a guide as to which clusters are to be searched. Simulation experiments are reported on.

Rothnie, J.B.,Jr., Lozano, T., "Attribute Based File Organization in a Paged Memory Environment", CACM 17, 1974, pp. 63-69.
[Hashing, Data Clustering, Data Structuring]

This paper suggests the computation of hash addresses ("pages" instead of single locations) as a function of several keys. This not only reduces search time (or the need for inverted files) but also clusters the data conveniently.

Skinner, C.W., "A Heuristic Approach to Inductive Inference in Fact Retrieval Systems", CACM 17, 1974, pp. 707-712.
[Data Clustering]

The scheme here is to cluster very closely linked data (many properties in common). In this way examination of a typical cluster member or cluster centroid may be predictive of information about a given member-- even when such information is missing from the data base.

van Rijsbergen, C.J., "Further Experiments With Hierarchic Clustering in Document Retrieval", Inform. Stor. Retr. 10, 1974, pp. 1-14.
[Clustering, Retrieval Strategies]

This is a continuation of the work of Jardine and Van Rijsbergen (1971). A more general search strategy (allowing for the retrieval of more than one cluster) is presented and tests on several document files are discussed.

van Rijsbergen, C.J., "An Algorithm for Information Structuring and Retrieval", Comp. J. 14, 1971, pp. 407-411.
[Data Clustering, Retrieval Strategies]

This is an article on document clustering which emphasizes the clustering algorithm. Use of single-linked hierarchical clusters with representatives arranged in a tree structure allows retrievals of various size clusters matching the query more or less well. "Moderate success" on a collection of 200 documents is reported.

Wong, E., Chiang, T.C., "Canonical Structure in Attribute Based File Organization", CACM 14, 1971, pp. 593-597. [Data Structuring, Clustering]

The idea here is to cluster the data into small, disjoint sets or "atoms", each atom being always retrieved as an entity. As the authors remark, it may happen that each record is an atom.

Hardgrave, W.F., "The Prospects for Large Capacity Set Support Systems Imbedded Within Generalized Data Management Systems", International Computing Symposium 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1974, pp. 549-556.
[Set Theoretic Structures, Data Compression]

A method for maintaining and manipulating sets on mass storage is described. The main result of the paper is a compression technique for representing relatively small subsets of a large universe.

Marron, B.A., de Maine, P.A.D., "Automatic Data Compression", CACM 10, 1967, pp. 711-715.
[Data Compression]

This paper seems to contain the earliest discussion of an automatic, language independent, alphanumeric string compressor.

Maurer, W.D., "File Compression Using Huffman Coding", Computing Methods in Optimization Problems 2, L. Zadeh, L. Neustadt, A. Balakrishan, eds., Academic Press, 1969.
[Data Compression]

This is the original paper on the use of Huffman codes for file compression. An algorithm for encoding is given in some detail. Maurer suggests that character combinations (e.g., common words) as well as single characters should be considered as "symbols" to be encoded.

McCarthy, J.P., "Automatic File Compression", International Computing Symposium 1973, A. Gunther, B. Levrat and H. Lipps, eds., North Holland, 1974.
[Data Compression]

The basic technique used here is Huffman coding. The paper is important because of the detailed description of an algorithm for automatic text analysis and selection of the strings to be encoded.

Mommens, J.H., Raviv, J., "Coding for Data Compaction", IBM Research Report RC 5150, November 1974.
[Data Compression]

This is a belated report on old (ca. 1970) compression work done at IBM. Several approaches are described with emphasis on software and hardware implementation. Results of experiments on real data are given.

Mulford, J.B., Ridall, R.K., "Data Compression Techniques for Economic Processing of Large Commercial Files", Proc. Symposium on Information Storage and Retrieval, ACM, 1971, pp. 207-215.
[Data Compression]

The authors used a combination of schemes (elimination of obvious data redundancies, coding of lengthy fields which were inconvenient to code on input, Huffman coding, etc.) to achieve a 4.7 compression ratio on a large commercial data base.

Ruth, S.S., Kreutzer, P.J., "Data Compression for Large Business Files", Datamation, Sept. 1972, pp. 62-66.
[Data Compression]

This is a good review and evaluation of compression techniques particularly applicable to large military data bases. The authors recommend Huffman coding of characters plus common patterns, and have obtained a 2.5 compression ratio on a large, dense data base.

Snyderman, M., Hunt, B., "The Myriad Virtues of Text Compaction", Datamation, Dec. 1970, pp. 36-40.
[Data Compression]

The scheme here is to scan a text character by character, combining the most frequently used characters (A,E, etc.) with the one following to form a single coded character. The compression ratio is clearly less than 2 and tends to be about 1.5.

Wagner, R., "Common Phrases and Minimum-Space Text Storage", CACM 16, 1973, pp. 148-152.
[Data Compression]

This paper addresses the following problem: given an encoding of certain strings and a message containing these strings but with overlap, how is the message best encoded? The dynamic programming algorithm given here may be too unwieldy for large data sets.

Wagner, R., "Indexing Design Considerations", IBM Syst. J. 12, 1973, pp. 351-367.
[Data Accessing, Data Structuring, Data Compression]

Although written in the context of the IBM Virtual Storage Access Method project, this paper is a good introduction to the design, maintenance, compression, etc. of indexes.

Wells, M., "File Compression Using Variable Length Encoding", Comp. J. 15, Nov. 1972, pp. 308-313.
[Data Compression]

The compression technique discussed here is simply Huffman coding. Some consideration is given to implementation of encoding and decoding, and possible extensions (non-binary Huffman codes, self-synchronizing codes) are briefly mentioned.

Anderson, R., Cert, V., Harslem, E., Heafner, J., Madden, J., Metcalfe, R., Shoshani, A., White, J., Wood, D., "Data Reconfiguration Service--An Implementation Specification", RFC 166, NIC 6780, May 1971.
[Data Reconfiguration, Protocol, Language]

This paper gives the specifications of the Data Reconfiguration Service (DRS), which is a software mechanism to reformat Network data streams.

Bleier, R.E., "Data Definition Standardization", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1970, pp. 68-86.
[Data Definition Language]

The data definition languages (DDL) of a few general-purpose systems are described. Also, attributes of data that should be considered in a standard DDL are mentioned.

Boyce, R.F., Chamberlin, D.D., "Using a Structured English Query Language as a Data Definition Facility", IBM Research Report RJ 1318, 1973.
[Data Definition Language]

A data definition language for a relational data base is proposed. Included are facilities for specifying alternate views of the data, rules for data conversion, and integrity constraints.

Boyce, R.F., Chamberlin, D.D., Hammer, M.M., King, W.F., "Specifying Queries as Relational Expressions", Proc. ACM SIGPLAN-SIGIR Interface Meeting, 1975, pp. 31-38.
[Query Languages, Relational Theory]

The authors present SQUARE, a set oriented data sublanguage. SQUARE attempts to mimic how people use tables to obtain information.

Bracchi, G., Fedeli, A., Paolini, A., "A Language for a Relational Data Base Management System", Proc. Sixth Annual Princeton Conf. on Information Sciences and Systems, 1972, pp. 84-92.
[Relational Query Language]

This paper illustrates COLARD, which is a non-procedural language for defining, creating, maintaining, updating and querying a relational data base, which is viewed as a collection of time-varying relations of assorted degrees. The generalized set theoretical operators for manipulating hierarchical relations are discussed. Language statements refer only to the user's logical data representation and are independent of underlying data base management system technology.

Chai, D.T., "Language Considerations for Information Management Systems", Proc. ACM, 1974, pp. 443-450.
[Natural Language]

Arguments against using English as the query language for information management systems are preseted. The difficult problem is determining the intended meaning of the request.

Chamberlin, D.D., Boyce, R.F., "SEQUEL: A Structured English Query Language", IBM Research Report RJ 1394, 1974.
[Relational Query Language]

A structured English query language for accessing a relational data base is presented. Queries are formulated as set-oriented table look-ups rather than selecting a row at a time.

CODASYL, "An Information Algebra", CACM 4, April 1962, pp. 190-204.
[Data Languages]

This report represents the results of the first phase of the work of the Language Structure Group. The goal of this work is to arrive at a proper structure for a machine-independent problem-defining language at the systems level of data processing. The report is based on the mathematical model "An Information Algebra", developed primarily by R. Bosak. A philosophy for the professional people who are vitally concerned with providing a working language for the systems analyst's use is presented.

CODASYL Data Base Task Group, "April 1971 Report", ACM, New York City, April 1971.
[Data Description Language, Data Manipulation Language]

The DBTG is concerned with the sharing of data management by multiple applications. It proposes a technique for superimposing a view (sub-schema) on the data base and a language to manipulate the data.

Codd, E.F., "A Database Sublanguage Founded on the Relational Calculus", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 35-68.
[Query Languages]

The author describes ALPHA, a data base sublanguage founded on the relational calculus, and compares it with other data base sublanguages.

Codd, E.F., "Seven Steps to Rendezvous with the Casual User", Proc. IFIP TC-2 Working Conference on Data Base Management Systems, 1974.
[Query Languages, Relational Theory]

The underlying concepts of a natural English query language are described. It is assumed that the user will not correctly state his query on his first attempt and it is the responsibility of the system to help him rephrase the query.

Codd, E.F., "Relational Completeness of a Data Sublanguage", Data Base Systems, R. Rustin, ed., Prentice-Hall, 1972, pp. 65-98.
[Query Languages]

A relational algebra which operates on Codd's model of a relational data base is defined and shown to be complete. A relational calculus is defined and an algorithm is given to map the calculus onto the algebra. The calculus and algebra are compared in terms of ease of augmentation, search optimization, authorization capability, and closeness to natural language.

Dennis, J.B., "On the Exchange of Data", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1970, pp. 41-66.
[Data Definition Language, Data Structures]

This paper addresses the problem of moving data between computer installations, which may differ in their hardware, software, or program libraries and data files.

Dostert, B.H., Thompson, F.3., "How Features Resolve Syntactic Ambiguity", Proc. Symposium on Information Storage and Retrieval, ACM, 1971, pp. 19-32.
[Natural Language]

Techniques for resolving ambiguities in natural language using the context of the ambiguity are discussed.

Earley, J., "On the Semantics of Data Structures", Data Base Systems, R. Rustin, ed., Prentice-Hall, 1972, pp. 23-32.
[Data Languages]

Some ideas about what properties a language should have in order to deal with data structures is presented. There are three levels of description of data structures which should be handled: 1) the implementation (machine) level, 2) a logical (semantic) level in which access paths are specified explicitly, and 3) a logical level in which only the relationships between data items are specified.

Ellis, M.E., Nelson, K.H., "A Data Description Language for Hierarchical Data Files", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1970, pp. 87-106.
[Data Description Language]

The paper begins with a discussion of the objectives and restrictions of the language, continues with a complete language description, and concludes with remarks on the language processor and extensions to the language.

Engles, R.W., "An Analysis of the April 1971 Data Base Task Group Report", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 69-91.
[Data Structures, Data Definition Language, Data Manipulation Language]

The strengths and weaknesses of the DBTG report are discussed. Suggestions are then presented for some of its problems.

Fehder, P.L., "The Representation-Independent Lanuage, Part 1: Introduction and Subsetting Operation", IBM Research Report RJ 1121, 1972.
[Query Languages]

RIL, a query language for specifying transactions in the context of an entity-set-structured data base, is described. Boolean expressions and temporary variables are used to subset entity sets.

Greenfeld, N.R., "Quantification in a Relational Data System", AFIPS 43, 1974, pp. 71-75.
[Query Optimization]

A brief overview of relational data base theory is given including examples using LEAP. The author is primarily interested in methods to decrease the time required to answer a query. Some techniques include dynamic algorithm selection, iterative optimization and query tuning.

Kellogg, C., Burger, J., Diller, J., Fogt, K., "The Converse Natural Language Data Management System: Current Status and Plans", Proc. Symposium on Information Storage and Retrieval, ACM, 1971, pp. 33-46.
[Query Languages, Natural Language]

A natural-language compiler is described which accepts sentences in a user extendable English subset, produces surface and deep structured syntactic analyses, and uses a network of concepts to construct semantic interpretations.

King, P.F., Shemer, J.E., "ARS--An Interactive Reporting System", Proc. ACM SIGPLAN-SIGIR Interface Meeting, 1973, pp. 161-166.
[Query Languages]

A report-generating language is described. This system prompts the user for a description of the desired data and the display format.

Lorie, R.A., Symonds, A.J., "A Relational Access Method for Interactive Applications", Data Base Systems, R. Rustin, ed., Prentice-Hall, 1972.
[Relational Data System, Data Languages]

This paper describes an experimental system that demonstrates interactive problem solving. The system is designed to meet the language and data base requirements of problem-solving. The components of the system are: a relational access method and an APL interpreter that provides the terminal user with the full facilities of APL/360. The data representation for a communications network design problem is discussed as an example.

Senko, M.E., "Data Description Language in the Context of a Multilevel Structured Description: Diam II With Foral", IBM Research Report RC 5073, 1974.
[Data Description Language]

A five level data description language is described. These levels are the end user, information, string, encoding, and physical levels.

Sibley, E.H., Taylor, R.W., "A Data Definition and Mapping Language", CACM 16, Dec. 1973, pp. 750-759.
[Data Structures, Data Definition Language]

The authors propose that Data Definition Languages must be extended to provide a means of specifying the storage structure the data will be mapped onto. It is hoped that this will provide data independence.

Thompson, F.B., "English for the Computer", AFIPS 29, 1966, pp. 349-356.
[Natural Language]

It is the central thesis of the paper that, "when the subject matter of English is limited to material whose interrelationships are specifiable in a limited number of precisely structured categories, English becomes a formal language".

Thompson, F.B., Lockemann, P.C., Dostert, B., Deverill, R.S., "REL: A Rapidly Extensible Language System", Proc. ACM, 1969, pp. 399-414.
[Natural Language]

REL is a English language system which allows the user to extend the language to fit his particular needs. For the system to work efficiently, the user's data structures must reflect his conceptual organization of the data.

Baskin, H., Borgerson, B., Roberts, R., "PRIME--A Modular Architecture for Terminal Oriented Systems", AFIPS SJCC 40, 1972, pp. 431-437.
[Operating System, Multi-processing, Security, Error Detection, Error Recovery, Time Sharing, Computer Hardware, Reliability]

In this system a basic assumption is that failures exist as a normal occurence, rather than a special state, and they must be treated while continuing as near normal operation as possible. PRIME is a modular, canonical system consisting of n identical subsystems which can process n independent jobs with a high degree of protection from each other.

Baum, R.I., Hsiao, D.K., "A Semantic Model for Protection Mechanisms in the Data Base System", Eighth Hawaii Int'l. Conf. on System Sciences, 1975, pp. 175-179.
[Access Control, Data Security]

Given a data base, the relationships which exist between items in the data base, and the fact that a certain user is not to gain knowledge of certain items, this paper presents a variety of protection methods which vary in complexity of implementation and the total amount of information withheld.

Bensoussan, A., Clingen, C., Daley, R., "The MULTICS Virtual Memory", ACM Second Symposium on Operating Systems Principles, October 1969, pp. 30-42.
[MULTICS, Virtual Memory, Access Control, Data Sharing, Segmentation, Paging, Address Space]

Design and implementation considerations of segmentation and paging in MULTICS are discussed in detail. It is shown how the MULTICS supervisor, in conjunction with the GE 645 segmentation and paging hardware, utilizes the virtual memory.

Bressler, R., "Free File Transfer", RFC 487, Apr. 1973.
[Access Control, Accounting, FTP, Security]

This RFC discusses briefly an access control and accounting problem inherent in a network where each host does its own user validation. Also see RFC's 501 and 505.

Browne, P., Steinauer, D., "A Model for Access Control", ACM SIGFIDET Workshop on Data Description, Access and Control, 1971, pp. 241-262.
[Access Control, Resource Sharing, Authorization, Protection]

The problems of authorization for a multiple-user resource sharing data processing system are discussed. The requirements for the access of objects (e.g., terminals, users, programs, etc.) to other objects are covered in some detail. A model for access control is developed which combines the military-type level (tree-structured) classification and a category or clique classification. No discussion is given of efficiency, issues of identification or other advantages and disadvantages of the model.

Cerf, V., Kahn, R., "Host and Process Level Protocols for Internetwork Communication", Inter Network Working Group Draft Report, July 1973.
[Host-Host Protocol, Flow Control, Reliability]

This paper describes the inter-network protocol developed by the inter-network working group. The protocol provides clean handling of process-process communication and flow control. It can best be described as a hybrid message-switch protocol.

Chambers, J.M., "A User-controlled Synchronization Method", IBM SIGOPS, 1974, pp. 16-25.
[Deadlock Prevention, Process Synchronization]

This paoer discusses a method of inter-process communication by which processes can request resources, find out whether those resources have been received, and detect deadlock without ever necessaily being blocked. This allows the processes to possibly take alternative actions when the requested resources are not currently available.

Chu, W.W., Ohlmacher, G., "Avoiding Deadlock in Distributed Data Bases", Proc. ACM, 1974, pp. 156-160.
[Access Control, Data Base Integrity, Deadlock Prevention, Distributed System]

This paper discusses three methods of deadlock prevention or detection based on availability of prior knowledge of file use by a process, and whether files are pre- or demand-allocated. Ways of implementing all three techniques on a distributed network are presented.

Collier, W.W., "Asynchronous Interactions on Shared Data", IBM SIGOPS, 1974.
[Deadlock Prevention, Process Synchronization]

If the hardware on which a program is to be run has uninterruptable instructions for manipulating the memory referenced by two processes, then those processes can be written so that they can both reference memory without hindering each other.

Daley, R., Dennis, J., "Virtual Memory, Processes, and Sharing in MULTICS", CACM 11, May 1968, pp. 306-312.
[MULTICS, Virtual Memory, Data Sharing, Dynamic Linking, Multi-programming, Storage Management, Storage Hierarchies, Resource Sharing, Security]

Basic concepts involved in the design of the MULTICS operating system, such as processes, address space, and virtual memory, are introduced and defined. Procedure and data sharing is discussed and the dynamic transformation of symbolic references into virtual machine addresses is described in detail.

Dean, A.,Jr., "Data Privacy and Integrity Requirements for On-line Data Management Systems", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 279-298.
[Data Security, Data Integrity]

This paper identifies the data privacy and integrity capabilities required by an online data management system. The overall operation of an online data management system, the hardware, operating software, and application software of an online data management system are described in terms of the data privacy and integrity capabilities to be supplied by each of these parts of a system.

Farber, D., "Networks: An Introduction", Datamation 18, April 1972, pp. 36-40.
[Network]

This article gives an overview of this expanding field by examining seven typical networks: ARPA, CYBERNET, DCS, MERIT, OCTOPUS, TSS, and TVCC.

Florentin, J.J., "Consistency Auditing of Databases", Computer Journal 17, Jan. 1974, pp. 52-58.
[Data Base Integrity]

This paper discusses an approach for checking the consistency of the information in a data base, by requiring that every transaction be allowed to happen only if it will not cause the data to violate specified mathematical rules.

Frank, H., Chou, W., "Topological Optimization of Computer Networks", IEEE 60, Nov. 1972, pp. 1385-1397.
[Network Design, Network Topology, Centralized System, Distributed Computer Network, ARPANET, Reliability, Network Bandwidth]

Modeling, analysis and design problems, and methodologies for centralized and distributed computer-communication networks are discussed. The basic problem is to specify the location and capacity of each communication link within the network. The design objective is to provide a low-cost network which satisfies constraints of response time, throughput, reliability, and other parameters. (author's abstract).

Frank, H., Frisch, I.T., Chou, W., "Topological Considerations in the Design of the ARPA Computer Network", AFIPS SJCC, 1970, pp. 581-587.
[ARPANET, Network Design, Network Topology, Reliability, Routing, Network]

A design algorithm to establish where links should be established within the ARPA network is given. The algorithm presented obtains a local optimum. Some constraints are included in the decision, such as route selection, capacity assignment, link delay, etc. A graph of cost against throughput is presented to aid in choosing between local optima.

Friedman, T.D., "The Authorization Problem in Shared Files", IBM Systems Journal 9, No. 4, 1970.
[Authorization, Data Accessing, Data Security, Privacy, Security]

The author develops a scheme for controlling access to data at the per-field level which can withstand almost all attempts at circumvention, with small effects to response time.

Graham, G.S., Denning, P.J., "Protection--Principles and Practice", AFIPS SJCC, 1972, pp. 417-429.
[Security, Protection, Access Control, Domain]

This paper builds upon Lampson's domains (FJCC 1969). An expanded domain scheme using a larger number of types of access is explained in detail, and proven correct. Implementation of the scheme is discussed, including comparisons with several existing operating systems (OS/360, RC 4000, Multics).

Graham, R., "Protection in an Information Processing Utility", CACM 11, May 1968, pp. 365-369.
[Protection, Privacy, Security, Access Control, Data Sharing]

Information processing utility properties which make protection necessary are discussed and the essential properties for a protection scheme are defined. An abstract model of the hardware features and companion software necessary to implement this model are described.

Hassing, T., Hampton, R., Bailey, G., Gardella, R., "A Loop Network for General Purpose Communication in a Heterogeneous World", Data Networks: Analysis and Design, DATACOM73, 1973, pp. 88-96.
[Network Topology, Protocol, Security, Data Sharing]

A packet switching data communictions network under development at the National Security Agency for resource sharing and future development of distributed processing and filing systems is described. The network will consist of a hierarchy of interconnected loops or rings, probably based on Bell System T carrier digital transmission technology. Also discussed are the means of nodal connection to the loops, nodal configuration, network protocols, design and security considerations, and implications for the future.

Hawryszkiewych, I.T., Dennis, J.B., "An Approach to Proving the Correctness of Data Base Operations", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1972, pp. 323-348.

[Relational Data System, Integrity]

The authors present an abstract model of a relational data base and primitive operations on this model which allow sharing of data and concurrent use of the data base.

Heath, I., "Unacceptable File Operations in a Relational Data Base", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 19-34.
[Relational Structures, Data Integrity]

This paper is written within the context of a relational data base model as presented by E.F. Codd in "A Relational Model of Data for Large Shared Data Banks" and serves as a companion paper to his paper "Further Normalization of the Data Base Relational Model". The central thesis is that a file operation should not produce unexpected "side effects" in order to maintain a restriction (such as one-one, or many-one) on the file.

Hoffman, L.J., "The Formulary Model for Flexible Privacy and Access Controls", AFIPS 39, 1971, pp. 587-601.
[Access Control, Data Accessing, Privacy]

This paper discusses a method for using a set of procedures to dynamically control access to the information in a data base. This is done in such a way that access can be determined on a per item (rather than per file) basis.

Johnson, P.R., Thomas, R.H., "The Maintenance of Duplicate Databases", NIC #31507, Jan. 1975.
[Concurrent Use, Data Base Integrity, Distributed System]

This paper presents a method which (by representing each item in a data base as a quintuple containing information such as time created, time last modified, etc.) allows several distributed computers to maintain multiple copies of a data base in consistent states.

King, P.F., Collmeyer, A.J., "Database Sharing-An Efficient Mechanism for Supporting Concurrent Processes", AFIPS 42, 1973, pp. 271-275.
[Concurrent Use, Sharing of Data]

A lock-unlock mechanism, which provides for concurrent use of a data base and efficiently detects deadlock, is described.

Lampson, B.W., "Protection", Proc. Fifth Princeton Symposium on Information Sciences and Systems, March 1971, pp. 437-443.
[Access Control, Security]

Abstract models are given which reflect the properties of most existing mechanisms for enforcing protection or access control, together with some possible implementations. The properties of existing systems are explicated in terms of the model and implementations. (author's abstract)

Lampson, B.W., "Dynamic Protection Structures", AFIPS FJCC, 1969, pp. 27-38.
[Security, Protection, Access Control, Domain]

This paper describes domains, or the set of capabilities (access rights) of a process. Most aspects of protection are discussed in this context, including passing permissions between domains, transfer of control between domains, and proprietary programs (mutually suspicious subsystems).

McQuillan, J., "Software Checksumming in the IMP and Network Reliability", RFC 528, NIC 17164, June 1973.
[ARPANET, IMP, Reliability]

This paper describes in some detail modifications that were made to the ARPANET IMP and TIP programs to increase reliability. Some history is presented which led to the inclusion of software checksums for end to end checking of packets and checksums on IMP and TIP memories. Future plans for subnet changes are outlined.

Morris, J.H., "Protection in Programming Languages", CACM 16, Jan. 1973, pp. 15-21.
[Access Control, Protection]

This paper discusses protection of subprograms from malfunctions of other subprograms. Methods of enforcing user-created type restrictions thru software and restriction of variables to specific programs are discussed.

Needham, R., "Protection-A Current Research Area in Operating Systems", International Computing Symposium, 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1974, pp. 123-126.
[Protection, Security, Access Control, Process Synchronization]

An approach to protection, involving the notion of "regimes of protection" which denote the data a process can access, the variety of access permitted, that selection of other processes it may call, and transitions available to other regimes of protection, is presented. Advantages and disadvantages inherent in the scheme and its implementation are discussed.

Padlipsky, M.A., "Two Solutions to a File Transfer Access Problem", RFC 505, July 1973.
[Access Control, Accounting, File Transfer Protocol, Security]

This RFC addresses the problems of file access and accounting for file transfers in a network without network-wide accounting. The author offers two solutions which have been used and discusses their implications (See also RFC's 487 and 501.)

Padlipsky, M.A., "What is 'Free'?", RFC 491, Apr. 1973.
[File Transfer Protocol, Access Control, Security]

This RFC discusses the problems of free system access to provide services such as mail. The problem of the necessity of login is discussed, and several solutions are entertained.

Pogran, K.T., "Unmuddling Free File Transfer", RFC 501, May, 1973.
[Access Control, Accounting, File Transfer Protocol, Security]

This RFC elaborates on the suggestions made in Bressler's RFC 487. The author examines the problem from another point of view and points up several difficulties in security and accounting. Also see RFC's 487 and 505.

Popek, G.J., "Protection Structures", Computer, June 1974, pp. 22-33.
[Access Control, Data Security, Privacy, Protection, Security]

This paper starts with a general discussion of privacy and security. It then surveys control disciplines and protection models in some detail, with numerous references to the literature (84 references).

Popek, G.J., Kline, C.S., "Verifiable Protection Systems", To be presented at the ACM/IEEE Software Reliability Conference in LA, CA., Apr. 1975.
[File System Design, Kernel, Access Control, Data Security, Privacy, Protection, Security, Co-operating Processes, Multi-programming]

This paper primarily describes the UCLA/VM project at UCLA. UCLA/VM is a PDP 11/45-based virtual machine kernel that is verifiable, secure, and a virtualizing package that creates virtual PDP 11/45's.

Popek, G.J., Kline, C.S., "Verifiable Secure Operating System Software", AFIPS NCC, 1974, pp. 145-151.
[Access Control, Data Security, Privacy, Protection, Kernel, Security, Co-operating Processes, Multi-programming]

This paper discusses some aspects of secure operating systems, describes the concepts of security kernels and virtual machines, mentions several difficult security problems, and briefly mentions some aspects of verification of security kernels. The UCLA-VM system, a prototype security kernel and support software for the PDP 11/45, is mentioned briefly. Brief arguments concerning the cost of security are presented.

Saltzer, J.H., "Protection and the Control of Information Sharing in Multics", CACM 17, July 1974, pp. 338-402.
[MULTICS, Security, Privacy, Access Control, Data Sharing, Time Sharing, Virtual Memory, Storage Hierarchies]

Design principles and goals of Multics, a highly secure time-sharing system, are described. The schemes Multics uses to implement the design goals are described in detail, and a discussion of the tradeoffs and weaknesses of the implementation is included. The design principles and access control, authentication, and protection mechanisms discussed in this paper are important concepts in the field of secure operating systems.

Schroeder, M., Saltzer, J., "A Hardware Architecture for Implementing Protection Rings", CACM 15, March 1972, pp. 157-170.
[Protection, Security, Access Control, MULTICS, Virtual Memory]

Criteria are presented for the design of access control mechanisms, and the processor mechanisms for implementing protection rings are described. Finally, advantages and possible uses for protection rings are discussed.

Schroeder, M.D., "Cooperation of Mutually Suspicious Subsystems in a Computer Utility", Report #MAC TR-104, Project MAC, MIT.
[Security, Access Control, MULTICS]

A protection scheme based on capabilities and protection domains is described. The scheme is efficiently implementable in hardware and extends the methods developed for and implemented by the Honeywell 6180 MULTICS processor. Impacts of the design on the supporting operating system are discussed.

Shemer, J.E., Collmeyer, A.J., "Database Sharing: A Study of Interference, Roadblock and Deadlock", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1972, pp. 141-163.
[Concurrent Use]

By simulating concurrent use of a shared database, the authors find that database sharing at the group level is not expected to result in any significant deadlock or interference problems.

Shoshani, A., "Data Sharing in Computer Networks", NIC #12623, Oct. 1972.
[Concurrent Use, Data Sharing, Distributed System, Network]

The author presents several criteria by which to judge a distributed data management system, and then presents and analyzes five such systems. He concludes with some observations he has drawn based on his experience with implementing one of these systems.

Shoshani, A., Bernstein, A.J., "Synchronization in a Parallel-Accessed Data Base", CACM 12, Nov. 1969, pp. 604-607.
[Process Synchronization, Deadlock Prevention, Data Accessing, Data Sharing]

A data base is represented as a directed graph, and then the advatages and disadvantages of several algorithms for parallel access to the data base is discussed in terms of which situations can be handled, which can not, extra information required, and the length of time a node spends locked.

Sorenson, P., "Interprocess Communication in Real Time Systems", Operating systems Review 7, Oct. 1973, ACM, pp. 1-7.
[Interprocess Communication, Message Switching, Data Sharing, Process Synchronization]

Some schemes developed for nonreal-time interprocess communication are reviewed and it is shown they are inadequate for real-time situations. Two models are presented which insure shared data integrity in a real-time situation. The first model involves the control of process scheduling, the second uses multiple copies of data sets. Finally, the notions of real-time independent and dependent data are discussed in reference to real-time communication.

Summerill, L.F., Kory, M., "Security in Data Management", Eighth Hawaii Int'l Conf. on System Sciences, 1975, pp. 191-194.
[Access Control, Data Security, Security]

This paper briefly discusses many of the various aspects that go into a secure system, ranging from building security guards to aspects of monitoring process activities. Contains some good, short definitions of key phrases.

Summers, R.C., Fernandez, E.B., Coleman, C.D., "Shared Data Access Control with Programming Language Support", Eighth Hawaii Int'l. Conf. on System Sciences, 1975, pp. 187-190.
[Access Control]

This paper describes a method of classifying users, application programs, data items, restrictions based on specific data items, etc., into groups, in a way such that access control can be implemented with only a few changes to a currently existing higher level programing language.

Vold, H., Sjogren, B.H., "Optimal Backup of Data Bases", BIT 13, 1973, pp. 233-241.
[Data Base Recovery, Data Base Integrity]

Assuming that a data base is backed up by periodically dumping the data base to tape and maintaining a file of transactions which have taken place since the last dump, the authors present a mathematical criterion for determining the optimal interval for taking the dumps to minimize the cost of maintaining the data base at an operational level.

Wilkes, M.V., "On Preserving the Integrity of Data Bases", Comp. J. 15, Aug. 1972, pp. 191-194.
[Data Base Integrity]

A survey of techniques to maintain the integrity of data bases is given. These techniques include incremental dumping and the keeping of journals.

Wilkov, R., "Design of Computer Networks Based on a New Reliability Measure", Computer Communications Networks and Teletraffic, J. Fox, ed., 1972, pp. 371-384.
[Network Design, Network Topology, Reliability]

A new criterion for measuring reliability of computer and communications networks based on regular graph theory is suggested. A heuristic iterative procedure, based on this criterion, is given for constructing a maximally reliable network with a specified number of nodes and communications links. Finally, reliabilities of several proposed ARPANET topologies are compared with reliabilities of corresponding topologies derived by the given procedure.

Arora, S.R., Gallo, A., "Optimal Sizing, Loading, and Re-loading in a Multi-level Memory Hierarchy System", AFIPS SJCC 38, 1971, pp. 337-344.
[File Allocation]

On the assumption of a very simple model (no queueing delays) the authors "prove" that the most accessed blocks should be loaded into the fastest memory. An algorithm for optimal sizing of the levels (given a typical program mix) is discussed. A unique feature is a paragraph on dynamic allocation.

Bensoussan, A., Clingen, C., Daley, R., "The MULTICS Virtual Memory", ACM Second Symposium on Operating Systems Principles, October 1969, pp. 30-42.
[MULTICS, Virtual Memory, Access Control, Data Sharing, Segmentation, Paging, Address Space]

Design and implementation considerations of segmentation and paging in MULTICS are discussed in detail. It is shown how the MULTICS supervisor, in conjunction with the GE 645 segmentation and paging hardware, utilizes the virtual memory.

Casey, R.G., "Allocation of Copies of a File in an Information Network", AFIPS Conference Proceedings 40, 1972, pp. 617-625.
[File Allocation]

A model is set up to assign a file to network nodes based on minimizing the total update/query/storage costs. The number of file copies is a variable. An efficient search procedure is developed to find the true minimum, and heuristics for "good" solutions are discussed.

Casey, R.G., "Design of Tree Networks for Distributed Data", AFIPS Conference Proceedings 42, 1973, pp. 251-257.
[File Allocation, Network Topology]

This paper combines techniques for network design and Casey's file allocation algorithm (Casey, 1972) into a single algorithm for design of the network and allocation of the files, when information on data bases and their usage is known in advance.

Chen, P.P.S., "Optimal File Allocation in Multi-level Storage Systems", AFIPS Conference Proceedings 42, 1973, pp. 277-283.
[File Allocation]

A model for a multi-level storage system (for a central processor) is set up and several optimization problems (e.g. minimization of total storage cost with a mean response time constraint) are discussed. Inclusion of queueing delays make the model more realistic than that of earlier analyses. Algorithms are included.

Chen, P.P.S., Mealy, G.H., "Optimal Allocation of Files with Individual Response Time Requirements", Proc. Seventh Annual Princeton Conf. on Information Sciences and Systems, pp.1-4.
[File Allocation]

This work is similar to that reported in Chen (1973), except that different response time constraints may be assigned to individual files. A branch-and-bound algorithm is proposed.

Chien, R.T., Mark, E.A., "A Document Storage Method Based on Polarized Distance", JACM 21, 1974, pp. 233-245.
[File Allocation, Clustering, Retrieval Strategies]

Documents are clustered according to "weight" or number of non-zero terms in their binary index vectors. Theorems are developed to determine which clusters should be searched for a given query. A brief analysis compares the method with linear and inverted filing schemes.

Chu, W.W., "File Allocation in a Multiple Computer System", IEEE Trans. Computers C-18, Oct. 1969, pp. 885-889.
[File Allocation]

A model is set up and the author shows how an optimal file allocation may be obtained as the solution to a linear integer (zero-one) programming problem. The zero-one variables to be determined indicate whether or not a given file resides in a given processor. Use of the approach seems limited to situations where the number of processors and the number of files are small.

Chu, W.W., "Optimal File Allocation in a Computer Network", Computer Communications Networks, N. Abramson and F. Kuo, eds., Prentice Hall, 1973, pp. 82-94.
[File Allocation]

The technique here is basically the same as in Chu (1969), but the model is extended to include redundant file copies in order to achieve a prescribed level of file availability.

Daley, R., Dennis, J., "Virtual Memory, Processes, and Sharing in MULTICS", CACM 11, May 1968, pp. 306-312.
[MULTICS, Virtual Memory, Data Sharing, Dynamic Linking, Multi-programming, Storage Management, Storage Hierarchies, Resource Sharing, Security]

Basic concepts involved in the design of the MULTICS operating system, such as processes, address space, and virtual memory, are introduced and defined. Procedure and data sharing is discussed and the dynamic transformation of symbolic references into virtual machine addresses is described in detail.

Farber, D., "Networks: An Introduction", Datamation 18, April 1972, pp. 36-40.
[Network]

This article gives an overview of this expanding field by examining seven typical networks: ARPA, CYBERNET, DCS, MERIT, OCTOPUS, TSS, and TVCC.

Graham, R., "Protection in an Information Processing Utility", CACM 11, May 1968, pp. 365-369.
[Protection, Privacy, Security, Access Control, Data Sharing]

Information processing utility properties which make protection necessary are discussed and the essential properties for a protection scheme are defined. An abstract model of the hardware features and companion software necessary to implement this model are described.

Grossman, D.D., Silverman, H., "Placement of Records on a Secondary Storage Device to Minimize Access Time", JACM 20, 1973, pp. 429-438.
[File Allocation]

The problem analyzed here is: given an n-frame device (e.g. a disk) and n records, plus times required to move from one frame to another and a probabilistic model of the access sequence, find that placement of records in frames which minimizes average access time.

Hassing, T., Hampton, R., Bailey, G., Gardella, R., "A Loop Network for General Purpose Communication in a Heterogeneous World", Data Networks: Analysis and Design, DATACOM73, 1973, pp. 88-96.
[Network Topology, Protocol, Security, Data Sharing]

A packet switching data communictions network under development at the National Security Agency for resource sharing and future development of distributed processing and filing systems is described. The network will consist of a hierarchy of interconnected loops or rings, probably based on Bell System T carrier digital transmission technology. Also discussed are the means of nodal connection to the loops, nodal configuration, network protocols, design and security considerations, and implications for the future.

Levin, K.D., "Organizing Distributed Data Bases in Computer Networks", Ph.D. Dissertation, U. of Penn., 1974.
[File Allocation]

Levin, building on the work of Chu and Casey, presents search-type algorithms for solving the file allocation problem when interactions between files (e.g. the use of files by program files) must be taken into account and some files are restricted to certain locations.

Morgan, H.L., Levin, K.D., "Optimal Program and Data Locations in Computer Networks", Report 74-10-01, Dept. of Decision Sciences, The Wharton School, U. of Penn., 1974.
[File Allocation]

This is a brief summary of Levin's Ph.D. thesis (q.v.) on the network file allocation problem.

Ramamoorthy, C.V., Chandy, K.M., "Optimization of Memory Hierarchies in Multiprogrammed Systems", JACM 17, 1970, pp. 426-445.
[File Allocation, Memory System Design]

The techniques described may be used to determine at what levels files should be stored or to determine the design of the memory hierarchy (given data on file sizes and query frequencies). Mean response time is minimized under a total cost constraint. The algorithms use linear programming and branch-and-bound.

Saltzer, J.H., "Protection and the Control of Information Sharing in Multics", CACM 17, July 1974, pp. 338-402.
[MULTICS, Security, Privacy, Access Control, Data Sharing, Time Sharing, Virtual Memory, Storage Hierarchies]

Design principles and goals of Multics, a highly secure time-sharing system, are described. The schemes Multics uses to implement the design goals are described in detail, and a discussion of the tradeoffs and weaknesses of the implementation is included. The design principles and access control, authentication, and protection mechanisms discussed in this paper are important concepts in the field of secure operating systems.

Shoshani, A., "Data Sharing in Computer Networks", NIC #12623, Oct. 1972.
[Concurrent Use, Data Sharing, Distributed System, Network]

The author presents several criteria by which to judge a distributed data management system, and then presents and analyzes five such systems. He concludes with some observations he has drawn based on his experience with implementing one of these systems.

Shoshani, A., Bernstein, A.J., "Synchronization in a Parallel-Accessed Data Base", CACM 12, Nov. 1969, pp. 604-607.
[Process Synchronization, Deadlock Prevention, Data Accessing, Data Sharing]

A data base is represented as a directed graph, and then the advatages and disadvantages of several algorithms for parallel access to the data base is discussed in terms of which situations can be handled, which can not, extra information required, and the length of time a node spends locked.

Sorenson, P., "Interprocess Communication in Real Time Systems", Operating systems Review 7, Oct. 1973, ACM, pp. 1-7.
[Interprocess Communication, Message Switching, Data Sharing, Process Synchronization]

Some schemes developed for nonreal-time interprocess communication are reviewed and it is shown they are inadequate for real-time situations. Two models are presented which insure shared data integrity in a real-time situation. The first model involves the control of process scheduling, the second uses multiple copies of data sets. Finally, the notions of real-time independent and dependent data are discussed in reference to real-time communication.

Yue, P.C., Wong, C.K., "Storage Cost Considerations in Secondary Index Selection", IBM Research Report RC 5070, October 1974. [Data Structures, File Allocation, File System Design]

This paper combines the problem of choosing the best secondary indexes with the problem of best allocating the files to a memory hierarchy in an overall optimization analysis.

Network and Systems Environment Subtopics

8. Communications and Networks
9. Resource Allocation and Control
10. Systems Measurement and Analysis
11. Network Access Systems and Front-Ends
12. Security

Abramson, N., "Packet Switching with Satellites", AFIPS NCC, 1973, pp. 695-702.
[Packet Communication, Packet Radio, Satellite Communication]

The history of packet communication and the ALOHA Network are briefly presented. The ALOHA channel capacity and excess channel capacity results are derived. The properties of satellite channels are discussed in some detail, and current satellite communication experiments in progress among NASA Ames Research Center, University of Alaska, and University of Hawaii are described. A strong argument is given for a domestic satellite-based packet network.

Akkoyunlu, E., Bernstein, A., Schantz, R., "Interprocess Communication Facilities for Network Operating Systems", Computer, June 1974, pp. 46-55.
[Inter-process Communication, Ports]

The desirability of flexible interprocess communication (IPC) facilities in a network operating system is established, and three such facilities are described. They are Walden's IPC scheme (CACM 15, Apr. 1972), DCS (University of Calif. at Irvine), and SBS (State University of New York at Stony Brook).

Akkoyunlu, E., Bernstein, A., Schantz, R., "Software Communication Across Machine Boundaries", IEEE COMPCON73, 1973, pp. 203-205.
[Interprocess Communication, Data Port, Thin Line Communication, Modularity, Co-operating Processes]

The software communication facility for an operating system designed to function as part of a computer network is described. The facility is implemented as data ports and allows a process to control information flow between itself and other objects (e.g., files and processes) by using a uniform set of primitives, without regard to the actual location of the object in the network.

Akkoyunlu, R., Bernstein, A., Schantz, R., "An Operating System for a Network Environment", Department of Computer Science, SUNY at Stony Brook, Tech. Rept. #5.
[Front-end Processor, Ports]

This paper describes a layered operating system based on the inter-process communication techniques of Walden and Balzer to be built on a PDP-15. The system is layered along interesting lines: logical, data port, known item, and user levels.

Arora, S.R., Gallo, A., "The Optimal Organization of Multiprogrammed Multi-Level Memory", Proc. ACM Workshop on System Performance Evaluation, 1971, pp. 104-141.
[Measurement, Performance Evaluation, Queueing Theory]

This paper combines a cyclic queueing model and a linear optimization model to investigate cost and throughput issues. The paper derives several interesting results with respect to effects of multiprogramming on response time, cost, and throughput capacity.

Aupperle, E., "MERIT Computer Network: Hardware Considerations", Computer Networks, R. Rustin, ed., Prentice Hall, 1972, pp. 49-63.
[MERIT, Centralized System, Distributed System, Communications Processor, Front End Processor, Telecommunications]

The configuration chosen for the MERIT Computer Network is discussed in comparison with alternative choices, and the direction of future techniques of operation is outlined. The principal aspects of the hardware--the communications computer, the telephonic communications, and the interfaces--are described in detail.

Balzer, R.M., "PORTS - A Method for Dynamic Interprogram Communications and Job Control", AFIPS SJCC, 1971, pp. 485-489.
[Inter-process Communication, Thin-line Communication]

A unified approach to communication between processes and all entities external to the process is presented. PORTS is a co-routine-like mechanism that permits processes to obtain input data and produce output results independent of the source or destination, respectively.

Baskett, F., Muntz, R.R., "Queueing Network Models with Different Classes of Customers", IEEE COMPCON72, 1972, pp. 205-209.
[Queueing Network, Network Modeling, Queueing Theory, Network Performance]

Four different types of service centers are handled, and steady state equations are obtained. The model includes considerations for different types of customers with different priorities. An example which resembles a CPU with four I/O devices is studied, and graphs for amount of utilization of each service center (vs. number of customers) are given.

Belsnes, D., "Flow Control in Packet Switching Networks", InterNetwork Working Group Note #63, Oct. 1974.
[Flow Control, Packet Communication, Congestion]

A discussion is given of the window scheme, an end-to-end untested flow control mechanism, and their possible advantages to a network.

Benoit, J.W., Graf-Webster, E., "REX--A Resource Location and Acquisition Service for the ARPA Computer Network", MITRE Technical Report #387, January 1974, MITRE Corp., McLean, Va.
[ARPANET, Command Language, Distributed Computing, Documentation, Network Accounting, On-line Documentation, Resource Sharing]

Several existing resource sharing systems on the ARPANET are briefly described, and some basic needs of a resource sharing system are discussed. The REX system is described. REX is a system which allows a user to locate a desired resource on the net. This is done using local files. No host-host communication is required.

Bernstein, A., Deflefsen, G., Kerr, R., "Process Control and Communication", ACM Second Symposium on Operating Systems Principles, October 1969, pp. 60-66.
[Interprocess Communication, Process Control, Co-operating Processes]

The structure of processes within a general purpose operating system and primitives available for process control and inter-process communication are described.

Bhushan, A., "Data and File Transfer--Some Measurement Results", RFC 573, Sept. 1973.
[File Transfer Protocol, Network Measurement]

This RFC describes results of file transfer measurements on the ARPANET between the MIT-DMS system (a PDP-10) and five other PDP-10's on the network (with either TENEX or ITS operating systems). The measurements are primarily of transfer rate, response time, cost, and availability.

Bhushan, A., Braden, R., Crowther, W., Harslem, E., Heafner, J., McKenzie, A., Melvin, J., Sundberg, R., Watson, R., White, J., "The Data Transfer Protocol", RFC 264, NIC 7812, Nov. 1971.
[Data Transmission, Protocol, Remote Job Entry]

Although it would be possible to include some or even all applications in an all-inclusive file transfer protocol, a separation between data transfer and application functions may provide flexibility in implementation, and reduce complexity. The authors have defined a data transfer protocol (DTP) which should be used for transfer of all data in file transfer, remote job entry, and other applications protocols.

Blanc, R.P., "Review of Computer Networking Technology", NBS Technical Note 804, National Bureau of Standards, Jan. 1974.
[Network, TYMNET, CYBERNET, GE Information Services, MERIT, ARPANET, TSS Network]

This report gives a short overview and description of current network Technology, then describes and performs cursory analyses of several existing networks.

Bolt, Beranek, and Newman, Inc., "Specifications for the Interconnection of a Host and an IMP", Report #1822, Bolt, Beranek, and Newman, Inc., Cambridge, Ma.
[Protocol, IMP, IMP-Host Protocol, Host-IMP Protocol, Communications Equipment, ARPANET, Packet Communication]

This report describes the physical, hardware, and software environment a computer site must establish to connect to the ARPANET via a BBN Interface Message Processor. IMP-HOST and HOST-IMP message leader formats are described for the implementer of HOST-IMP communications software. Hardware interface specifications are given for the implementer of interface hardware. This document is periodically updated to reflect hardware/software changes in the IMP.

Bressler, R., "Interprocess Communication on the ARPA Computer Network", MIT Civil Engineering MS Thesis, June 1971.
[Inter-process Communication, Co-operating Processes, Resource Sharing, Time Sharing, IMP, NCP, Socket, Flow Control, ARPANET]

The development of a Network Control Program (NCP) for the ITS PDP-10 timesharing system is outlined. The relationship between the I/O structure of a time sharing system and the network as an I/O device is defined. Finally, the control commands and the choice of sockets as the mapping device for the link space is examined and suggestions for improvement in the NCP are given.

Bressler, R., Murphy, D., Walden, D., "A Proposed Experiment with a Message Switching Protocol", RFC 333, NIC 9926, May 1972.
[Message Switched Protocol, Protocol, Communications, Host-Host Protocol, NCP]

A message switching protocol (MSP) is a system whose function is to switch messages among its ports. The authors propose, as an aside to network development using the current NCPs, to rethink the design of NCP-level software beginning with a consideration of MSPs. The organization of the lowest level host-host protocol in the ARPA Network around MSPs, and how this organization would affect the implementation of host software, is described.

British Post Office, "Experimental Packet Switched Service", Issue 3, January 1974.
[Packet Communication, Protocol, Distributed System, EPSS]

A detailed specification of the British Post Office experimental packet switched data communication service is given.

Buzen, J., "Analysis of System Bottlenecks Using a Queueing Network Model", SIGOPS Workshop on System Performance Evaluation, ACM, April 1971, pp. 82-103.
[System Performance, Queueing Theory, Traffic Analysis]

A model of a single control processor and multiple I/O processors is studied (central server model). All services are assumed exponential and the number of customers is a constant, N, corresponding to the number of partitions in the system. Steady-state probabilities of utilization of each processor are obtained as well as queue lengths. System performance is evaluated and bottlenecks defined.

Cady, G.M., "Computation and Communication Trade-off Studies: An Analytical Model of Computer Networks", Proc. WESCON Conf., 1972, pp. 1-12.
[Measurement, Performance Evaluation, Queueing Theory, Simulation]

The author develops a comprehensive model of a computer network combining the attributes of the hosts and the communications subnet. The article primarily discusses the assumptions and theory on which the model is built.

Casey, R.G., "Design of Tree Networks for Distributed Data", AFIPS Conference Proceedings 42, 1973, pp. 251-257.
[File Allocation, Network Topology]

This paper combines techniques for network design and Casey's file allocation algorithm (Casey, 1972) into a single algorithm for design of the network and allocation of the files, when information on data bases and their usage is known in advance.

Cerf, V., "The Current Flow-Control Scheme for IMPSYS", RFC 442, NIC 13774, Jan. 1973.
[IMP, Flow Control, Communications Subsystem, ARPANET, Traffic Control]

The ARPANET IMP flow control as of Jan 1973 is presented in an understandable form. The control was intended to eliminate unnecessary retransmissions of packets when the net is under heavy load and to increase net bandwidth. The strategy involves multiple acknowledgements piggy-backed onto data packets between two IMPS.

Cerf, V., "An Assessment of ARPANET Protocols", RFC 635, Apr. 1974.
[IMP-IMP Protocol, Host-Host Protocol, Network Performance]

This paper discusses some of the theoretical and practial aspects of the ARPA IMP-IMP and Host-Host protocols. Of major importance are problems such as packet re-assembly, retransmission, and duplicate detection. The author makes recommendations for new protocols based on past experience.

Cerf, V., Dalal, Y., Sunshine, C., "Specification of Internet Transmission Control Program", Inter Network Working Group Paper #72, 1974.
[Host-Host Protocol, IPC, Flow Control]

This paper provides a detailed description of the Internet protocol and the control program necessary to implement it. The paper covers the problems of reconnection, flow control, and measurement in the environment of the new protocol. The document is a guide to implementers of the protocol.

Cerf, V., Kahn, R., "Host and Process Level Protocols for Internetwork Communication", Inter Network Working Group Draft Report, July 1973.
[Host-Host Protocol, Flow Control, Reliability]

This paper describes the inter-network protocol developed by the inter-network working group. The protocol provides clean handling of process-process communication and flow control. It can best be described as a hybrid message-switch protocol.

Cerf, V., Naylor, W., "Selected ARPA Network Measurement Experiments", Proc. IEEE COMPCON72, 1972, pp. 201-204.
[ARPANET, Routing, Flow Control]

This paper analyzes the cost of multipacket message re-assembly in the ARPANET IMP. This paper represents an argument for the reservation of the correct number of re-assembly buffers in the destination IMP.

Chesson, G.L., "Communication and Control in a Cluster Network", Proceedings ACM, 1974, pp. 509-514.
[Interprocess Communication]

A communications scheme for an interconnected network of processors typified by short-delay communications, local memory, and software controlled scheduling, resource allocation, and interprocess communication, is described. The scheme permits a program to use all the available multiprocessing power it needs while yielding the same results if operated with one processor.

Cocanower, A., "MERIT Computer System: Software Considerations", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 65-77.
[Traffic Control, MERIT, Process Synchronization, Inter-process Communication, Communications Processor, Front End Processor, Multi-tasking, Semaphores]

The programming considerations for the MERIT Computer Network are described briefly with respect to host and communication computer philosophy, organization, component description and function, operating system design, and traffic regulation. Implementation difficulties and potential user problems are discussed.

Cotton, I., "Network Management Survey", Seventh Hawaii International Conference on System Sciences - Subconference on Computer Networks, 1974.
[Network Management, ARPANET, MERIT, TYMNET]

A brief comparison in table format is presented of management practices for the ARPANET, MERIT, TUCC, Oregon State, and Tymnet networks. All information is from reference material.

Crocker, S., Heafner, J., Metcalfe, R., Postel, J., "Function-oriented Protocols for the ARPA Computer Network", AFIPS SJCC, 1972, pp. 271-279.
[ARPANET, Protocol, Interprocess Communication]

A brief description is given of low level protocols which make up the communications subnet of the ARPANET. The use of remote interactive systems through high level function-oriented protocols--such as FTP, TELNET, and RJE--is discussed.

Crowther, W., Heart, F., McKenzie, A., McQuillan, J., Walden, D., "Report on Network Design Issues", InterNetwork Working Group Note #64, Oct. 31, 1974.
[Flow Control, Store and Forward Networks, Network Interconnection, Network Design, Packet Communication, ARPANET, Deadlock]

Packet switching design issues--design requirements; message processing by the subnet; single packet messages only; packet size; lock-ups; interreference; and other bugs and short comings--are discussed, especially as they relate to the ARPA Network.

Currey, J.E., "Tablet Handling in an Interactive Graphics Environment", Computer Display Review, Keydata Corp., Watertown, Mass.
[Graphics, Man-machine Communication]

A "user-trainable" tablet input system is described. An example of a circuit design session using user-defined input symbols for entering and editing components is given.

Davidson, J., "An Echoing Strategy for Satellite Links", RFC 357, NIC 10599, June, 1972.
[Satellite Communication, Telnet Protocol]

This document is a description of a technique for reducing the apparent echoing delay experienced by terminal users when the echoing is being performed over a long-delay, e.g., satellite path. These ideas were essentially implemented in the second version of the ARPANET TELNET protocol (Remote Controlled Transmission and Echoing Option).

Davies, D., "The Principles of a Data Communication Network for Computers and Remote Peripherals", IFIPS 68, North Holland Pub Co., 1969, pp. 709-715.
[Store and Forward Networks, Packet Communication]

An outline for a store-and-forward common-carrier data network is proposed.

Davies, D., Bartlett, K., Scantlebury, R., Wilkinson, P., "A Digital Communication Network for Computers Giving Rapid Response at Remote Terminals", ACM Symposium on Operating System Principles, October 1967.
[Store and Forward Neworks, Common Carrier Data Network, Network Design, Packet Communication, Time Sharing]

A design for a common-carrier data network is described. Topics include link design, node design, message transmission, software organization, network performance estimates and node performance estimates.

Davies, D.W., Barber, D.L.A., "Communication Networks for Computers", John Wiley and Sons, 1973.
[ARPANET, Communications, Error Detection, Error Recovery, Flow Control, Network Bandwidth, Network Design, Packet Communication Analysis, Routing]

A comprehensive text dealing with most aspects of computer networks from the basic communications hardware up to network software. The detail is severe on some data communications techniques.

Denning, P.J., "A Statistical Model for Console Behavior in Multi-user Computers", CACM 11, 1968, pp. 605-612.
[Measurement, Performance Evaluation, Statistics, Queueing Theory]

This paper develops a highly useful model for console behavior that answers questions relevant to the number of blocked processes, buffer requirements, rate processes can execute, etc.

Despres, R., Guinaudeau, P., "RCP--The Experimental Packet-Switched Data Transmission Service of the French PTT", Inter Network Working Group General Note #67, Aug. 1974.
[Packet Communication, Store and Forward Networks, Virtual Memory Flow Control]

An experimental packet-switched data transmission network, based on the use of virtual circuits, is described. Detailed information is given on the network hardware configuration, network commands, and protocols for virtual circuit switching.

Deutsch, P.L., "Cross-country Network Bandwidth", RFC 567, NIC 18970, Sept. 1973.
[ARPANET, Traffic Analysis, Network Bandwidth]

This paper presents a very brief analysis attributing network peak loads to the undue delays in the cross country echoing of characters over ARPANET.

Dijkstra, E.W., "Hierarchical Ordering of Sequential Processes", Acta Informatica 1, Springer-Verlag, 1971, pp. 115-138.
[Multi-programming, Process Synchronization, Interprocess Communication]

This paper introduces the concept of "layered" design of operating systems. It then discusses the semaphore, a mechanism used by "virtual machines" or processes to guarantee mutual exclusion from critical sections and effect synchronization of "consumers" and "producers" of a consumable resource. A problem of mutual exclusion called the "five dining philosophers" is discussed and a solution proposed.

Dijkstra, E.W., "Co-operating Sequential Processes", Programming Languages, F. Genuys, ed., Academic Press, New York 1968.
[Resource Sharing, Multi-programming, Process Synchronization, Interprocess Communication, Semaphore]

This paper describes the general problems encountered by co-operating sequential processes and some specific solutions. A set of primitives to effect co-ordination between co-operating sequential processes is motivated and developed. These primitives, the P and V operations on an object called a semaphore, are discussed in detail with examples. Co-operation using status variables, with semaphores providing mutual exclusion, to permit more arbitrary co-ordination than semaphores allow is also described. Finally, the banker's algorithm, a deadlock prevention scheme, is motivated and described.

Estrin, G., Kleinrock L., "Models and Measurements for Time-shared Computer Utilities.", Proc. Conf. ACM, 1967, pp. 85-96.
[Measurement, Performance Evaluation, Queueing Theory]

This paper is a very good survey of the predicted characteristics of queueing theory models of time sharing systems and the results of several measurement projects of such systems. The validity of the models with respect to the measurements is discussed..

Farber, D., "Networks: An Introduction", Datamation 18, April 1972, pp. 36-40.
[Network]

This article gives an overview of this expanding field by examining seven typical networks: ARPA, CYBERNET, DCS, MERIT, OCTOPUS, TSS, and TVCC.

Farber, D., "Data Ring Oriented Computer Networks", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 73-93.
[Distributed System, DCS, Error Detection, Error Correction, Process Synchronization, Ring Network]

A general discussion of broadband communications systems, with a detailed discussion of a particular distributed system known as a data ring, is presented in the context of its application to computer networks. The functional advantages as well as the technical difficulties in the implementation and use of the data ring are discussed. (author abstract)

Farber, D., Larson, K., "The System Architecture of the Distributed Computer System--The Communications System", Computer Communications Networks & Teletraffic, J. Fox, ed., 1972, pp. 21-27.
[DCS, Distributed System Technology, Broadcast Mode, Protocol, Error Detection, Error Correction, Ring Network]

The Distributed Computer System (DCS) is a data communications ring. The communications protocols are described and the advantages are given for addressing mesages to processes, removing a message from the ring only at the originating Ring Interface, and message sequencing. Error detection and correction are also discussed.

Farber, D., Larson, K., "The Structure of a Distributed Computing System--Software", Computer Communications Networks and Teletraffic, J. Fox, ed., 1972, pp. 539-545.
[DCS, Ring Network, Protocol, Distributed Network Technology, Inter-process Communication, Process Synchronization, Ring Protocols]

A general description of the design goals and hardware topology of the Distributed Computing System (DCS) is given. It is shown how they shaped the operating system. A description is given of the level structure of the operating system. Future plans for the network are presented.

Farber, D.J., "The Structure of a Distributed Computer System--The Distributed File System", First Int'l Conf. on Computer Communications, Oct. 1972, pp. 364-370.
[Distributed System, File System Design, Network, DCS]

The DCS is a distributed computer system in which resource allocation is handled by the processes bartering with one another directly rather than through a central processor. This paper discusses the file system on the DCS, which has properties such that losing any processor does not affect any files not stored on that processor, and moving a file from one processor to another in no way affects the user's view of how to access the file.

Fletcher, J., "OCTOPUS Communications Structure", Seventh Annual IEEE Computer Society International Conference (COMPCON 73), 1972, pp. 21-23.
[OCTOPUS, Message Transmission, File Transfer]

A general description is given of the OCTOPUS compter network and its underlying subnetwork structure. Message transmission and file transfer as a means of communication over the subnets are briefly discussed.

Fralick, S.C., Brandin, D.H., Kuo, F.F., Harrison, C., "Digital Terminals for Packet Broadcasting", Draft Report, Stanford Research Institute, 1975.
[Packet Radio, Time Sharing, Packet Communications]

This report describes some of the major considerations in the construction of small packet radio terminals. The radio transceiver, processor, and input-output devices are discussed. The Aloha Integrated Control it built at the University of Hawaii and an experimental unit being built at at Stanford Research Institute are discussed.

Fralick, S.C., Garrett, J.C., "Technological Considerations for Packet Radio Networks", Draft Report, Stanford Research Institute, 1975.
[Packet Communications, Packet Radio]

This paper discusses the applications of current technology to radio packet-switched systems, particularly to repeaters. The signal strength required for reliable transmission of data is discussed.

Frank, H., "Optimal Design of Computer Networks", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 167-183.
[Centralized System, Distributed System, Traffic Analysis, Routing, Network Design]

The design of both centralized and decentralized computer networks is considered, with particular emphasis on layout, link capacity assignment, delay analysis, and network route selection. Both general design problems and specific computational results are discussed.

Frank, H., Chou, W., "Network Properties of the ARPA Computer Net", Networks 4, John Wiley & Sons, Inc., 1974, pp. 213-239.
[ARPANET, Network Bandwidth, Packet Communication Analysis]

This paper starts with an overview of ARPA network techniques. Throughput and cost analyses are carried out for a variety of topological, cost, traffic, and line speed criteria. Reliability analyses are also made, with the primary objective of minimizing cost while maintaining reliability.

Frank, H., Chou, W., "Topological Optimization of Computer Networks", IEEE 60, Nov. 1972, pp. 1385-1397.
[Network Design, Network Topology, Centralized System, Distributed Computer Network, ARPANET, Reliability, Network Bandwidth]

Modeling, analysis and design problems, and methodologies for centralized and distributed computer-communication networks are discussed. The basic problem is to specify the location and capacity of each communication link within the network. The design objective is to provide a low-cost network which satisfies constraints of response time, throughput, reliability, and other parameters. (author's abstract).

Frank, H., Frisch, I.T., Chou, W., "Topological Considerations in the Design of the ARPA Computer Network", AFIPS SJCC, 1970, pp. 581-587.
[ARPANET, Network Design, Network Topology, Reliability, Routing, Network]

A design algorithm to establish where links should be established within the ARPA network is given. The algorithm presented obtains a local optimum. Some constraints are included in the decision, such as route selection, capacity assignment, link delay, etc. A graph of cost against throughput is presented to aid in choosing between local optima.

Frank, H., Frisch, I.T., Van Slyke, R., Chou, W.S., "Optimal Design of Centralized Computer Networks", Networks 1, 1971, pp. 43-57.
[Centralized System, Network Topology, Network Bandwidth, Network Modeling, Network Performance Optimization]

A design approach for centralized computer networks is presented. An algorithm to decide link capacities for an arbitrary cost structure is given and an example is studied. An algorithm to find locally optimal topologic solutions for the network is shown and an example given.

Frank, H., Kleinrock, L., Kahn, R.E., "Computer Communication Network Design--Experience with Theory and Practice", AFIPS SJCC 40, 1972, pp. 255-270.
[Distributed System Technology, Message Switching, Network Design, Store and Forward Communications, Resource Sharing, ARPANET, Network Topology, Modeling, Flow Control, Routing, Error Detection, Error Recovery]

Major problems relating to IMP design, topological design, and network modeling on the ARPA network are discussed and the major design techniques which have evolved to deal with them are given.

Gazis, D.C., "Modeling and Optimal Control of Congested Transportation Systems", Networks 4, 1974, pp. 113-124.
[Queueing Theory, Traffic Analysis, Store and Forward Networks]

An approach is discussed for the modeling of congested transportation systems as store-and-forward networks, analogous to communication networks.

Gordon, W.J., Newell, G.F., "Closed Queueing Systems with Exponential Servers", Operations Research 15, No. 2, 1967, pp. 254-265.
[Queueing Theory]

This paper deals with constant population closed queueing networks. It is shown that such systems are stochastically equivalent to open systems in which the population may not exceed N. Equilibrium conditions for such a system is solved by a separation of variable technique.

Gordon, W.J., Newell, G.F., "Cyclic Queueing Systems with Restricted Length Queues", Operations Research 15, 1967, pp. 266-277.
[Network Modeling, Network Performance, Queueing Network, Queueing Theory, Congestion]

This paper is concerned with stochastic behavior of a system with capacity restrictions. The closed cyclic system considered is shown to be stochastically equivalent to open sysems in which the number of customers is a random variable. Duality is introduced (as holes moving in the opposite direction). Equilibrium equations for several systems are obtained.

Habermann, A.N., "Synchronization of Communicating Processes", CACM 15, Mar. 1972, pp. 171-176.
[Interprocess Communication, Multi-programming, Process Synchronization]

A formal process synchronization scheme that facilitates correctness proofs of inter-process interaction is described.

Hassing, T., Hampton, R., Bailey, G., Gardella, R., "A Loop Network for General Purpose Communication in a Heterogeneous World", Data Networks: Analysis and Design, DATACOM73, 1973, pp. 88-96.
[Network Topology, Protocol, Security, Data Sharing]

A packet switching data communictions network under development at the National Security Agency for resource sharing and future development of distributed processing and filing systems is described. The network will consist of a hierarchy of interconnected loops or rings, probably based on Bell System T carrier digital transmission technology. Also discussed are the means of nodal connection to the loops, nodal configuration, network protocols, design and security considerations, and implications for the future.

Hayes, J.F., Sherman, D.N., "Traffic Analysis of a Ring Switched Data Transmission System", Bell System Technical Journal 50, November 1971, pp. 2947-2978.
[Traffic Analysis, Network Performance, Ring Network]

This paper is primarily concerned with the analysis of queueing delays in a ring (loop) data transmission system. The results are presented in a set of curves where delay (normalized to units of message length) is plotted as a function of number of stations and source activity. Detailed study is made of the uniform traffic pattern, where each user is identical and communicates equally. A computer simulation was performed and agreed well with the theoretical results.

Heart, F.E., Ornstein, S.M., Crowther, W.R., Barker, W.B., "A New Minicomputer/Multiprocessor for the ARPA Network", AFIPS NCC 42, 1973, pp. 529-537.
[Multiprocessor, ARPANET, IMP]

This paper describes the design of the high speed IMP for the ARPANET. The techniques described for interconnecting a number of storage media (a pruned n x n interconnection) provides a highly flexible structure for handling failures and a large variety of loads and speeds.

Herzog, B., "MERIT Computer Network", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 45-48.
[MERIT, Resource Sharing, Front End Processor, Distributed System, Network Design, Network Management]

The objectives and organization of the MERIT Computer Network are discussed from their inception through their projected future development. The historical and administrative compexities are presented. (author's abstract)

Hornbuckle, G.D., "The Computer Graphics User/Machine Interface", IEEE Transactions on Human Factors, HFE-8, March 1967, p. 17.
[Display, Graphics, Interactive, Man-machine Communication, Terminals, Terminal Technology]

This paper discusses the use of a graphics terminal with a stylus-type input. Such a system would be superior to a conventional alphanumeric keyboard terminal for many tasks, e.g., editing, debugging, and circuit design.

Jackson, J.R., "Networks of Waiting Lines", Operations Research 5, 1957, pp. 518-521.
[Network Modeling, Queueing Theory, Queueing Networks]

'A machine shop' is described as a collection of departments, each with exponential service and exponential arrivals from outside the system. The steady-state distribution of the waiting-line lengths for each department is shown to be independent from that for other departments if mean arrival rate is properly defined.

Kahn, R., "Terminal Access to the ARPA Computer Network", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 147-166.
[ARPANET, Store and Forward Communications, IMP, Resource Sharing, Time Sharing]

The goals and current developments in the ARPA Network are discussed. The characteristics of a Terminal IMP are described. The Terminal IMP (TIP) will permit direct connection to the ARPA Network.

Kalin, R., "Achieving Reliable Communication", RFC 203, NIC #7168, August 1971.
[Protocol, Communications, Error Detection, Error Recovery]

A non-standard protocol, suitable for either second or third level use, is proposed with the intent of providing error resistant and highly reliable communication channels. Errors introduced by message garbling, message loss, and message pickup are considered. Measures for increasing throughput are also discussed.

Karush, A.D., "Two Approaches for Measuring the Performance of Time-Sharing Systems", Proc. Second Symposium on Operating System Principles, Princeton, 1969, pp. 159-166.
[Measurement, Performance Evaluation, Queueing Theory, Benchmark]

This paper considers the "stimulus-black box" and analytic approaches to system measurements. The black box method is seen as cheaper and does not require intimate knowledge of the system. The two techniques are compared for cost, inconvenience, kinds of measurements, and other criteria.

Kaye, A., "Analysis of a Distributed Control Loop for Data Transmission", Computer Communications Networks & Teletraffic, J. Fox, ed., 1972, pp. 47-58.
[Data Transmission, Ring Network, Traffic Analysis, Distributed System]

The paper analyzes a loop system for the transmission of fixed length messages in which control is passed around the loop from terminal to terminal. Each terminal has a buffer of one message-length. Analytic formulae for the distribution, mean value, and variance of message waiting time, together with the proportion of blocked messages are obtained. Useful approximations for lightly loaded systems are also given. (author's abstract)

Kimbleton, S.R., Moore, C.G., "A Probabilistic Framework for System Performance Evaluation", Proc. ACM Workshop on System Performance Evaluation, 1971, pp. 337-361.
[Measurement, Performance Evaluation, Queueing Theory]

This paper describes a method for comparing throughput, turn-around time, and availability for a processor bound computer system. The authors feel the method is extendable to any system with a "clearly defined limiting resource". The paper also contains some very interesting data on process activity.

Kleinrock, L, "Survey of Analytical Methods in Queueing Networks", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 185-205.
[Network Topology, Network Performance Optimization, Traffic Analysis, Nodal Blocking, ARPANET]

A brief survey of tools and methods used for the analysis of computer networks is presented. Queueing theory is applied to some simple cases and the results compared with those obtained from simulation and experiment. Discussion of the applicability of queueing analysis is given for more complex cases. (author's abstract)

Kleinrock, L., "Scheduling, Queueing, and Delays in Time-shared Systems and Computer Networks", Computer-Communication Networks, N. Abramson and F. Kuo, eds., Prentice Hall, pp. 95-141.
[Network Performance Optimization, Process Scheduling, Resource Allocation]

This paper consists of two nearly independent mathematical analyses based on queueing theory--the first part is a good review and analysis of the various time sharing scheduling algorithms. The second (and shorter) part discusses network analysis and optimization techniques.

Kleinrock, L., "Research Areas in Computer Communications", Computer Communication Review, SIGCOMM Quarterly Review 4, W. Chu, ed., July 1974, pp. 1-4.
[Communications, Distributed System, Flow Control, Resource Sharing]

The major research areas in computer communications are discussed. The specific problems emphasized by the author are: design of computer communication networks consisting of thousands of nodes, flow control in all networks, and the problems of privacy, security and resource control and allocation in distributed systems.

Kleinrock, L., "Certain Analytic Results for Time-shared Processors", IFIP Congress 68, pp. 838-845.
[Time Sharing, Terminals, Modeling, Queueing Theory, Traffic Analysis]

A basic model for time-shared systems with M consoles is introduced and analyzed. Published measurements on existing computer systems demonstrate the accuracy of the model in describing the behavior of the normalized average response time, taken as the performance measure of these systems. (author's abstract)

Kleinrock, L., "Analytic and Simulation Methods in Computer Network Design", AFIPS SJCC, 1970, pp. 569-579.
[Queueing Theory, ARPANET, Network Modeling, Network Bandwidth, Network Design, Network Performance, Routing]

Analytical techniques are used to analyze computer networks such as the ARPANET. Methods to synthesize an optimal channel capacity assignment are discussed for three different cost functions, including the real life case of the Telpak rates for leased transmission.

Kleinrock, L., Naylor, W., Opderbeck, H., "A Study of Line Overhead in the ARPANET", General InterNetwork Working Group Note #71, Sept. 1974.
[ARPANET, Packet Communication, Flow Control, Network Measurement, Network Performance, Traffic Analysis, Network Performance Optimization, Protocol, Congestion]

Communication channel overhead on the ARPANET is classified into levels of protocol hierarchy and studied for models of system use. Some measurements of line efficiency on the ARPANET are presented and extrapolations to a heavily loaded network are made. Results are derived for a recently suggested replacement for the HOST-HOST protocol and a comparison is made.

Knott, G.D., "A Proposal for Certain Process Management and Intercommunication Primitives", Operating Systems Review 8, Sections 1-6, October 1974, ACM Special Interest Groups on Operating Systems, pp. 7-44.
[Process Control, Interprocess Communication]

The types of process management and intercommunication capabilities found in advanced system implementations (Multics, Tenex, TSS, etc.) and in current operating system theory are characterized. The user-level primitives necessary to support these capabilities are described and some examples are given. An extensive bibliography is also provided.

Kuo, F.F., Abramson, N., "Some Advances in Radio Communications for Computers", Proc. IEEE COMPCON73, 1972, pp. 57-60.
[Packet Radio, Satellite Communications]

A brief description of the ALOHA System, a UHF broadcast radio system, which has been under development at the University of Hawaii since 1968. The hardware and data formats are very briefly described. The status of the ALOHA System and a description of satellite work in progress are also described.

Labonte, R.C., "A General Purpose Digital Communications System for Operation on a Conventional CATV System", Proc. IEEE COMPCON73, 1973, pp. 85-88.
[Communications]

Technical details of a two-way CATV System are presented. The system could be a prototype for a "wired city", in which subscribers can use the CATV system for communication. Possibilities mentioned include a "paperless office", "electronic mail", and "interactive education".

Lay, W., Mills, D., Zelkowitz, M., "Design of a Distributed Computer Network for Resource Sharing", AIAA Computer Network Systems Conference, Paper #74-426, 1973.
[Distributed Computing, Resource Sharing, Time Sharing, Fault Tolerance, Kernel, Virtual Memory, Interprocess Communication, Message Switching, Resource Management, Ring Network]

A distributed operating system for an integrated network of non-homogeneous minicomputers is proposed. Current distributed computer network designs are discussed. The general organization of the prototype Distributed Computer Network (at the University of Maryland) including storage management, interprocess communication (via messages and ports), and resource management is discussed.

Lewin, M.H., "An Introduction to Computer Graphic Terminals", Proc. IEEE 55, Sept 1967, p. 1544.
[Graphics, Man-machine Communication, Terminals, Terminal Technology]

This paper describes the various different types of graphic devices available. Input and output are covered. The emphasis is on logical organization (e.g., how a picture is generated) and capabilities, rather than detailed design.

Licklider, J.C.R., "A Picture is Worth a Thousand Words-And it Costs...", AFIPS SJCC, 1969, p. 617.
[Graphics, Man-machine Communication, Terminals]

An introduction to an SJCC session on graphics which argues that insufficient use is being made of graphic terminals and their capabilities, and that such terminals are probably the best form of man-machine communication available.

Loomis, D., "Ring Communication Protocols", Technical Report #26, Dept. of Information and Computer Science, University of California at Irvine, January 1973.
[Protocols, Message Transmission, Distributed Control, Ring Network]

A number of schemes for coordinating message transmission among computing components which are connected together by a single unidirectional, continuous and circular communication channel are discussed. The paper also examines mechanisms using distributed control to allow message transmission by node without interference from each other.

Luther, W., "Conceptual Bases of CYBERNET", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 111-146.
[CYBERNET, Time Sharing, Remote Job Entry, Store and Forward Communications, Distributed System, Message Switching]

This paper is a detailed description of CYBERNET--a currently operating, extensive, commercial network. The communication facilities and particular hardware configurations are described in detail. A discussion of the computer as a public utility is also included. (author's abstract)

Mader, E., "A Protocol Experiment", RFC 700, Aug. 1974.
[Host-Host Protocol, Network]

This paper discusses an implementation of the Internet protocol between a Tenex and PDP-11 at BBN. A discussion of some extensions to the protocol and the difficulties encountered is presented along with a theoretical analysis of the bandwidth capabilities of the protocol.

Martel, C.C., Cunningham, I.M., Grushcow, M.S., "The BNR Network: A Canadian Experience with Packet Switching Technology", IFIP Congress 74, North Holland, 1974.
[Communication, Network]

This paper describes the initial work on a packet switched data network by Bell in Canada. The network is half-duplex with PDP-11's for message switches and interfaces IBM machines at three nodes.

McKay, D., Karp, D., "IBM Computer Network/440", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 29-43.
[Distributed System, Telecommunications, Centralized System, Network Control Language]

Network/440 is a heterogeneous, general purpose computer network as well as a research project on networking problems. This paper describes the present design and implementation, and what are forseen as important problems in the field of networking.

McKay, D., Karp, D., "Protocol for A Computer Network", IBM Systems Journal 12, Jan. 1973, pp. 94-105.
[Protocol, Message Switching]

Message processing concepts and a protocol for communications control among network users are discussed.

McKenzie, A., "TELNET Protocol Specification", NIC #18639.
[TELNET Protocol, Protocol, Inter-process Communication, ARPANET]

The ARPANET Network Virtual Terminal (NVT), a canonicalization of the concept of an interactive computer terminal, is defined. The protocol used to communicate with an NVT is referred to as TELNET. This document describes the basic form of "negotiated options", the mechanism used to modify NVT behavior with respect to echoing, format effectors, etc. Particular options are defined in separate papers. This document is the TELNET reference document and may be updated or superseded at some future date.

McKenzie, A., "Host/Host Protocol for the ARPA Network", NIC #8246.
[Host-Host Protocol, Protocol, Inter-process Communication, ARPANET]

This document explains the philosophy of the host-host inter-process communication protocol used in the ARPA network. It then explains in detail the operations that must be performed to implement the protocol. This is the reference document for this protocol and is periodically updated.

McKenzie, A.A., Cosell, B.P., McQuillan, J.M., Thorpe, M.J., "The Network Control Center for the ARPA Network", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[ARPANET, Network Control, Network Management]

The NCC is responsible for detecting, locating, and correcting failures in the ARPANET IMP communications network. This paper discusses the hardware and software used to accomplish this, along with several measurement facilities.

McQuillan, J., "Software Checksumming in the IMP and Network Reliability", RFC 528, NIC 17164, June 1973.
[ARPANET, IMP, Reliability]

This paper describes in some detail modifications that were made to the ARPANET IMP and TIP programs to increase reliability. Some history is presented which led to the inclusion of software checksums for end to end checking of packets and checksums on IMP and TIP memories. Future plans for subnet changes are outlined.

McQuillan, J., "Response to RFC 567-Cross Country Network Bandwidth", RFC 568, NIC 18971, September 1973.
[ARPANET, IMP, Bandwidth, Flow Control, Traffic Analysis]

Many salient points omitted in RFC 567 are underscored. The reason for tardy character echoing is attributed to delay in the hosts and subnet instead of bandwidth.

McQuillan, J., Crowther, W., Cosell, B., Walden, D., Heart, F., "Improvements in the Design and Performance of the ARPA Network", AFIPS FJCC, 1972, pp. 741-754.
[ARPANET, IMP, Network Design, IMP-IMP Protocol, Flow Control, Store and Forward Networks, Packet Communication, Network Measurement, Network Performance Optimization, Congestion, Deadlock]

New algorithms in the areas of source-to-destination sequence control, source-to-destination flow control, and IMP-to-IMP transmission control are given as a result of the discovery of logical flaws in the interface message processor (IMP) software. Changes in program structure are discussed. Measurements of network throughput, IMP reliability, and IMP performance are given.

Mendicino, S., "OCTOPUS: The Lawrence Radiation Laboratory Network", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 95-110.
[Centralized System, OCTOPUS, Distributed System, Data Transmission]

The evolution of the Lawrence Radiation Laboratory Livermore OCTOPUS from a centralized network to a distributed one, consisting of a superimposition of specialized sub-networks, is described.

Metcalfe, R., "Packet Communication", Rpt. #MAC TR-114, Project MAC, MIT, Dec. 1973.
[Protocol, Packet Communication, ARPANET, ALOHA, Network Bandwidth, Interprocess Communication, Thin-line Communications, Satellite Communication]

This report develops a theory of packet communication: it analyzes uses of computers in digital communication systems and examines structures for organizing computers in highly communicative environments. Various examples from existing computer networks are used to motivate and substantiate analysis of store-and-forward packet communication, broadcast packet communication, and distributed interprocess communication. Bandwidth, protocols, inter-node spacing, packet lengths, and other aspects of packet communication are examined from the standpoint of underlying theory.

Metcalfe, R., "Strategies for Interprocess Communication in a Distributed Computing System", Computer and Communications Networks and Teletraffic, J. Fox., ed., 1972, pp. 519-525.
[ARPANET, Protocol, Routing, Error Recovery, Interprocess Communication, Message Switching, Distributed System Technology, Ports]

Characteristics are given for distributed and centralized systems processes and protocols. Thin-wire (distributed) interprocess communication is explained and it is suggested that it should be used more generally in computer operating systems for reliability reasons.

Miller, E.F., Pritchard, E.L., "Process Control and File Management in Large Minicomputer Networks", Proc. IEEE COMPCON73, 1973, pp. 199-201.
[Computer Networks]

A proposal for providing a "floating" operating system (BOSS) which delegates authority as needed to "junior executives" (JEXs). "The study of the requirements for the control program(s) and the data management functions is anthropomorphic." A hierarchical structure similar to that of large companies is recommended for large minicomputer networks. Reliability problems with hierarchical structure in a distributed environment are not addressed.

Miller, S.W., "Display Requirements for Future Man-Machine Systems", IEEE Transactions on Electronic Devices, ED-18, Sept. 1971, p. 616.
[Graphics, Man-machine Communication, Interactive]

This paper discusses the need for interactive graphic devices. The major point made is that 8 1/2 by 11 inch, black-on-white, high resolution, inherent memory devices that rely on reflected light would be a big step toward insuring general acceptance of interactive graphics.

Mimno, N.W., Cosell, B.P., Walden, D.C., Butterfield, S.C., Levin, J.B., "Terminal Access to the ARPA Network: Experience and Improvements", Proc. IEEE COMPCON73, 1973, pp. 33-43.
[TIP, ARPANET]

A superficial look at the background, history, design, and continuing development of the ARPANET Terminal IMP (TIP).

Muntz, R.R., "Analytic Models for Computer System Performance Analysis", UCLA Computer Science Department Quarterly 2, Jan. 1974, pp. 49-66.
[Network Performance, Network Modeling, Queueing Theory]

Descriptions of several queueing theoretic models are given (Kleinrock's, Buzen's, Moore's, etc.) and restrictions and future developments are described. Some emphasis is put on the author's model which is the only one with different customer classes.

Naylor, W.E., "Real-time Transmission in a Packet Switched Network", Network Measurement Note 15, NIC 19014, Sept 1973.
[ARPANET, IMP, Packet Communication, Measurement, Data Transmission, Packet Communication Analysis]

An experiment was performed on the ARPA network to measure the transmission data rate that one could get for different message sizes. Messages of sizes 1, 40, 62 and 503 words were sent through 1, 3, and 6 "hops" (one hop is transmission from one IMP to a neighboring IMP). Finally, results from a theoretic model are compared with the data.

Neiger, N., "Comments on CCL", NIC 30071, 1974.
[User Support, Command Language, Network Command Language]

This paper discusses the proposal of the UULP on the ARPANET (see Tentative Proposal for a Unified User Level Protocol). This author sees the main problems as a contention between standardization and resource sharing, and suggests Thomas' view (see Comments on the Common Command Language Effort) as the best solution rather than resolving the contention as Padlipsky proposed.

Opderbeck, H., "Throughput Degradations for Single Packet Messages", RFC 632, NIC 30239, May 1974.
[ARPANET, Flow Control, IMP]

An experiment to measure the bandwidth of single packet message transmission on the ARPANET is reported. Only one fourth of the expected throughput was achieved in many cases. The IMP flow control mechanism is shown to be at fault and two solutions are proposed.

Opderbeck, H., Kleinrock, L., "The Influence of Control Procedures on the Performance of Packet-Switched Networks", Inter Network Working Group Note #62, Sept. 1974.
[Packet Communication Analysis, Deadlock, Error Detection, Error Recovery, Flow Control, ARPANET, Network Performance, Congestion]

The general aims and problems of flow control are discussed as they relate to the ARPANET. Some deadlocks and degradations which have been discovered are discussed.

Padlipsky, M.A., "Specification of the Unified User-Level Protocol", RFC 666, NIC #31396, 1974.
[Protocol, UULP, Time Sharing, Man-machine Communication, ARPANET]

This paper proposes and describes a user-level man and machine usable protocol for standardizing the user interface to time sharing systems. This allows a user or machine to perform many site-independent actions in a site-independent command language. Standardized input conventions and an initial set of commands are described.

Padlipsky, M.A., "Comments on CCL.DOC", USING CCL committee paper, 1974.
[Network Command Language, User Support, Command Language]

This paper contains Padlipsky's response to Thomas' comments (see Comments on the Common Command Language Effort). This paper addresses each point of Thomas' paper. This whole series makes good reading for the designer of a network command language.

Patil, S.S., "Limitations and Capabilities of Dijkstra's Semaphore Primitives for Coordination Among Processes", Computation Structures Group Memo 57, Project MAC, MIT. Feb. 1971.
[Process Synchronization, Semaphore, Interprocess Communication]

The "cigarette smoker's problem", a representative of a class of coordinations that cannot be performed with Dijkstra's P and V primitives without conditionals, is presented. An extension to the P and V primitives is proposed.

Pewitt, T.C., Su, S.Y.W., "Resource Demanded Paging and Dispatching to Optimize Resource Utilization in an Operating System", Proc. First Annual SIGME Symposium, 1973, pp. 29-36.
[Measurement, Performance Evaluation, Queueing Theory]

This paper uses Buzen's model for evaluation of an operating system. The authors then apply an iterative optimization scheme to determine optimum system parameters.

Postel, J., "Official Initial Connection Protocol", NIC #7101.
[Initial Connection Protocol, Protocol, Inter-process Communication, ARPANET]

This document describes the ARPANET Initial Connection Protocol (ICP), a protocol used to establish an inter-process communication link between two hosts. This is the official ICP document, and may be updated or superseded.

Pouzin, L., "A Proposal for Interconnecting Packet Switching Networks", InterNetwork Working Group Note #60, March 1974.
[Packet Communication, Store and Forward Networks, Gateway, Network Interconnection]

A proposal to allow point to point message transfer across several independent packet switching networks is described. Necessary protocols and possible constraints are discussed.

Pouzin, L., "CIGALE, The Packet Switching Machine of the CYCLADES Computer Network", IRIA MIT 556, Nov. 1973.
[CYCLADES, Communication Subsystem, Flow Control, Congestion, Routing]

This paper describes the design of the packet switching nodes of the CYCLADES network. The nodes, French MITRA 15's, implement the routing, flow control and other functions necessary for the maintenance of the communications subnetwork.

Quatse, J., Gaulene, P., Dodge, D., "The External Access Network of a Modular Computer System", AFIPS SJCC 40, 1972, pp. 783-789.
[Resource Sharing, Security, Message Processing, PRIME, Protection, Error Detection, Inter-process Communication]

The PRIME system consists of sets of modules dynamically reconfigured into separate subsystems. Three classes of communications are needed: processor-to-processor, processor-to-facility pool device-(e.g. disk drive), primary memory-to-facility pool device. This paper describes the structure and components of the External Access Network (EAN) developed for this purpose.

Roberts, L., Wessler, B., "Computer Network Development to Achieve Resource Sharing", AFIPS SJCC, 1970, pp. 543-549.
[ARPANET, Resource Sharing, Store-and-forward Networks, Network Topology, Network Design]

This slightly dated article gives the requirements, properties, and topology of the communications system chosen for the ARPANET. A quantitative comparison is made between the chosen ARPANET configuration and alternative network communications systems designs.

Roberts, L.G., "Extensions of Packet Communication Technology to a Hand Held Personal Terminal", AFIPS SJCC, 1972, pp. 295-298.
[Packet Radio, Packet Communications]

The feasibility of a hand-held computer terminal using packet radio techniques is discussed. The terminal would consist of a 256-character plasma screen, a five-button keyset, a radio transceiver, and control logic. A brief comparison of the random-access radio technique used with conventional frequency or time-division multiplexing is included.

Rose, G.A., "Computer Graphics Communications Systems", IFIP Congress 68, North Holland, 1968, p. 692.
[Communications, Graphics, Network, Terminal Technology]

Directly-coupled and buffered displays are briefly described. Three experimental systems are compared and discussed: ARDS project, Intergraphic project, IBM 1500 Instructional Display System. Linking of a large number of such devices into a network is discussed.

Rustin, R., "Computer Networks", Prentice-Hall, 1972.
[MERIT, OCTOPUS, DCN, CYBERNET, ARPANET, Computer Network]

This book is a series of articles on computer networks which were given at the Courant Institute of Mathematical Sciences at New York University Symposium on November 30-December 1, 1974. Authors and titles are: A. Weis, "Distributed Network Activity at IBM", B. McKay, D. Karp, "IBM Computer Network/440", B. Herzog, "MERIT Computer Network", A. Aupperle, "MERIT Computer Network: Hardware Considerations", A. Cocanower, "MERIT Computer Network: Software Considerations", D. Farber, "Data Ring Oriented Computer Networks", S. Mendicino, "OCTOPUS: The Lawrence Radiation Laboratory Network", W. Luther, "Conceptual Bases of CYBERNET", R. Kahn, "Terminal Access to the ARPA Computer Network", H. Frank, "Optimal Design of Computer Networks", L. Kleinrock, "Survey of Analytical Methods in Queueing Networks". For more complete annotations, see each individual author and title.

Schmid, H., "An Approach to the Communication and Synchronization of Processes", International Computing Symposium 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1973.
[Process Synchronization, Inter-process Communication, Petri Nets, Resource Sharing, Deadlock]

Primitives for the communication of concurrent processes are introduced. Using these primitives, process systems are split into processes independent of, and processes communicating with the environment, which allows easy transformation of process systems into Petri Nets. Finally, the implementation is discussed.

Sekino, A., "Throughput Analysis of Multiprogrammed Virtual Memory Computer Systems", Proc. First Annual SIGME Symposium, 1973, pp. 47-53.
[Measurement, Performance Evaluation, Paging, Queueing Theory]

This paper combines models of paging behavior of programs under multiprogramming, and of dual processor, multi-memory system with virtual memory to realistically evaluate throughput. The model is compared with actual data from MULTICS, and the effect of multiprogramming is evaluated.

Shoshani, A., "Data Sharing in Computer Networks", NIC #12623, Oct. 1972.
[Concurrent Use, Data Sharing, Distributed System, Network]

The author presents several criteria by which to judge a distributed data management system, and then presents and analyzes five such systems. He concludes with some observations he has drawn based on his experience with implementing one of these systems.

Sorenson, P., "Interprocess Communication in Real Time Systems", Operating systems Review 7, Oct. 1973, ACM, pp. 1-7.
[Interprocess Communication, Message Switching, Data Sharing, Process Synchronization]

Some schemes developed for nonreal-time interprocess communication are reviewed and it is shown they are inadequate for real-time situations. Two models are presented which insure shared data integrity in a real-time situation. The first model involves the control of process scheduling, the second uses multiple copies of data sets. Finally, the notions of real-time independent and dependent data are discussed in reference to real-time communication.

Spier, M., Organick, E., "The MULTICS Interprocess Communication Facility", Second ACM Symposium on Operating Systems Principles, October 1969, pp. 83-91.
[Inter-process Communication, MULTICS, Co-operating Processes, Process Synchronization]

The MULTICS interprocess communication (IPC) facility is discussed as it relates to capabilities produced as a result of basic system design. Shared data bases by virtue of unambiguous file system names, lock and unlock primitives, and block/wakeup services for processor multiplexing are the basis for the IPC facility.

Spragins, J.D., "Analysis of Loop Transmission Systems", Second Symposium on Problems in the Optimization of Data Communication Systems, 1971, pp. 175-182.
[Ring Network, Network Analysis, Queueing Theory]

A queueing theory analysis is performed on loop transmission systems with a single controller and random slot assignment with fixed slot size (the 'lazy suzan'). The paper discusses results of the research effort and emphasis the trade-off considerations in the design of loop systems (buffer size, terminal waiting lines, printer impact, etc.).

Sunshine, C., "Issues in Communication Protocol Design--Formal Correctness", InterNetwork Working Group Protocol Note #5, Oct. 1975.
[Protocol, Flow Control]

A formal description is given of the failure modes of a simple positive acknowledgement/retransmission protocol with and without sequencing.

Thomas, R., "Comments on the Common Command Language Effort", Personal paper to CCL Committee, 1974.
[User Support, Command Language, Network Command Language]

This paper discusses perceived problems with the proposals made in a predecessor of RFC 666. The paper considers the proposal from a different point of view shedding some light on questions such as machine readable versus human readable protocols, resource sharing, etc., and ends with a counter proposal.

Trafton, P.J., Blank, H.A., McAllister, N.F., "Data Transmission Network Computer-to-Computer Study", Computer Sciences Corporation, Proc. Second Symposium on Problems in the Optimization of Data Communications Systems, Palo Alto, Califiornia, October 1971, pp. 183-191.
[Error Detection, Error Correction, Communications, Data Transmission]

An analysis of the general intercomputer communication problem is performed. The model contains a number of intermediate communication links with an intermediate satellite link. The general store-and-forward technique is considered with an Automatic Repeat Request (ARQ) discipline and a Forward Error Correction (FEC) coding technique. A comparison with empirical data indicates the model is correct. ARQ is shown to be favored if each link has separate error control while FEC is more viable with end-to-end error control.

Volk, J.L., "Interactive Television Experiment in Reston, Virginia", Proc. IEEE COMPCON73, 1973, pp. 81-84.
[Communications]

A two-way CATV system operating in Reston, Va. was demonstrated by the MITRE Corporation. Services such as computer games, financial news, and educational materials were provided to the subscriber population. The subscribers used an ordinary television set with a refresh device (a commercial video recorder player) and a keyboard or touch-tone telephone as communications devices. A more economical approach is also described, and the economics of operation are discussed.

Walden, D., "A System for Interprocess Communication in a Resource-Sharing Computer Network", CACM 15, April 1972, pp. 221-230.
[Interprocess Communication, Ports, Message Switched Protocol]

A system of communication between processes based on messages is described and the communication system is extended so that it may be used between processes distributed throughout a computer network. the hypothetical application of the system to an existing network is discussed.

Wax, D.W., "The ALOHA Radio Modulation Scheme", ARPA Network Packet Radio Temporary Note #17, NIC 13863, Jan. 1973.
[Packet Radio]

The RF modulation scheme used by the ALOHA Network is described. The history and hardware are described in some detail. The performance of the modulation method is briefly presented.

Wilkov, R., "Design of Computer Networks Based on a New Reliability Measure", Computer Communications Networks and Teletraffic, J. Fox, ed., 1972, pp. 371-384.
[Network Design, Network Topology, Reliability]

A new criterion for measuring reliability of computer and communications networks based on regular graph theory is suggested. A heuristic iterative procedure, based on this criterion, is given for constructing a maximally reliable network with a specified number of nodes and communications links. Finally, reliabilities of several proposed ARPANET topologies are compared with reliabilities of corresponding topologies derived by the given procedure.

Yuen, M., Black, B., Newhall, E., Venetsanopoulos, A., "Traffic Flow in a Distributed Loop Switching System", Computer Communications Networks and Teletraffic, J. Fox, ed., 1972, pp. 29-46.
[Traffic Analysis, Message Switching, Distributed System, Ring Network]

An approximate analytical technique is outlined to calculate statistics for the traffic behavior of a distributed loop switching system under light traffic conditions. Simulation results were obtained from an IBM 370/165 for two separate models of traffic and flow. They agreed closely with those predicted by the statistical model. Finally, it is shown that the system can settle to a steady state even in the most adverse conditions.

Zimmerman, H., Elie, M., "Transport Protocol--Standard Host-Host Protocol for Heterogeneous Computer Networks", Reseau CYCLADES SCH519.1, June 1974.
[Host-Host Protocol, Flow Control, Error Recovery, Protocol]

This paper describes the host-host protocol for the French CYCLADE network. The protocol is significantly different than others in current use and is highly flexible.

Ackerman, W., Plummer, W., "An Implementation of a Multiprocessing Computer System", Proceedings ACM Symposium on Operating System Principles, 1967.
[Protection, Resource Allocation, Process Synchronization, Timesharing]

A multi-processing system implemented on a PDP-1 is discussed. Principal design criteria were: supervisor modularity through independent and synchronous processes; user mode process control of I/O functions; and an effective scheme for allocation and protection of system resources. Protection is implemented by a capability list (C-list) associated with each computation. Multi-processing primitives (meta-instructions), are discussed in detail in relation to interrupt handling, protection, I/O, and process control.

Akkoyunlu, E., Bernstein, A., Schantz, R., "Interprocess Communication Facilities for Network Operating Systems", Computer, June 1974, pp. 46-55.
[Inter-process Communication, Ports]

The desirability of flexible interprocess communication (IPC) facilities in a network operating system is established, and three such facilities are described. They are Walden's IPC scheme (CACM 15, Apr. 1972), DCS (University of Calif. at Irvine), and SBS (State University of New York at Stony Brook).

Akkoyunlu, E., Bernstein, A., Schantz, R., "Software Communication Across Machine Boundaries", IEEE COMPCON73, 1973, pp. 203-205.
[Interprocess Communication, Data Port, Thin Line Communication, Modularity, Co-operating Processes]

The software communication facility for an operating system designed to function as part of a computer network is described. The facility is implemented as data ports and allows a process to control information flow between itself and other objects (e.g., files and processes) by using a uniform set of primitives, without regard to the actual location of the object in the network.

Akkoyunlu, R., Bernstein, A., Schantz, R., "An Operating System for a Network Environment", Department of Computer Science, SUNY at Stony Brook, Tech. Rept. #5.
[Front-end Processor, Ports]

This paper describes a layered operating system based on the inter-process communication techniques of Walden and Balzer to be built on a PDP-15. The system is layered along interesting lines: logical, data port, known item, and user levels.

Alsberg, P., Day, J., Purdy, G., "Automated Resource Sharing on the ARPA Network", Center for Advanced Computation Report, Univ. of Ill., May 1973.
[Automated Resource Sharing, ARPANET, Distributed Computing, Security, Name Space Management, File Access Protocols, Process Control Protocols]

The design of a network-based distributed computing system to take advantage of some unique, heterogeneous resources available to the Center for Advanced Computation over the ARPANET is discussed. Four problems currently impeding the use of the ARPANET as a resource sharing utility--network security, name space management, file access protocols, and process control protocols, are discussed. In addition, a security coding system to control resource sharing is described.

Alsberg, P.A., "Project Dileptus--A Study of Distributed Computing", Center for Advanced Computation, University of Illinois, Dec. 1973 (draft).
[Distributed Computing, Protocol, Measurement, Process Control, Data Transfer]

The purpose of the Dileptus Project is to study the fundamental relationships involved in distributed systems, to empirically verify these relationships and to develop suitable protocols for distributed computing on the ARPA Network. Of particular interest is the harmonious co-operation of dissimilar machines in a hostile environment. Each component of the system must be suspicious of the correct functioning and good will of its multiple neighbors.

Alsberg, P.A., "Distributed Processing on the ARPA Network--Measurements of the Cost and Performance Tradeoffs for Numerical Tasks", Proc. Eighth Hawaii Internat'l Conference of System Sciences, 1975.
[Measurement, ARPANET, Resource Sharing, Performance Benchmark]

A benchmark of the cost (including network costs) and speed of a typical numerical computation (matrix inversion) for seven different machines on the ARPANET shows that distributed computing pays off earlier than first expected. Rough trends are also given for operations such as file management, console handling, bit flogging, and character manipulation. This paper is one of the first to actually show that distributed computation is cost effective.

Alsberg, P.A., Mills, C., "The Structure of the ILLIAC IV Operating System", Second ACM Symposium on Operating System Principles, Oct. 1969, pp. 92-96.
[Resource Allocation, Modularity]

The structure of the ILLIAC IV operating system is outlined in relation to system design goals.

Anderson, R., Cerf, V., Harslem, E., Heafner, J., Madden, J., Metcalfe, R., Shoshani, A., White, J., Wood, D., "Status Report on Proposed Data Reconfiguration Service", RFC 138, NIC 6715, April 1971.
[Data Reconfiguration, Protocol]

One approach to providing specific data I/O format adaptation is for those sites with substantial computing power to offer a data reconfiguration service--a proposed example of such a service is described.

Anderson, R., Cerf, V., Harslem, E., Heafner, J., Madden, J., Metcalfe, R., Shoshani, A., White, J., Wood, D., "Data Reconfiguration Service--An Implementation Specification", RFC 166, NIC 6780, May 1971.
[Data Reconfiguration, Protocol, Language]

This paper gives the specifications of the Data Reconfiguration Service (DRS), which is a software mechanism to reformat Network data streams.

Ash, W.L., Sibley, E.H., "TRAMP: An Interpretive Associative Processor with Deductive Capability", Proc. ACM, 1968, pp. 143-156.
[Associative Processing]

An "associative memory" is used to facilitate operations on binary relations. A deductive system is implemented using the binary relations. Hash coding is used to implement the "associative memory".

Aupperle, E., "MERIT Computer Network: Hardware Considerations", Computer Networks, R. Rustin, ed., Prentice Hall, 1972, pp. 49-63.
[MERIT, Centralized System, Distributed System, Communications Processor, Front End Processor, Telecommunications]

The configuration chosen for the MERIT Computer Network is discussed in comparison with alternative choices, and the direction of future techniques of operation is outlined. The principal aspects of the hardware--the communications computer, the telephonic communications, and the interfaces--are described in detail.

Baskett, F., Muntz, R.R., "Queueing Network Models with Different Classes of Customers", IEEE COMPCON72, 1972, pp. 205-209.
[Queueing Network, Network Modeling, Queueing Theory, Network Performance]

Four different types of service centers are handled, and steady state equations are obtained. The model includes considerations for different types of customers with different priorities. An example which resembles a CPU with four I/O devices is studied, and graphs for amount of utilization of each service center (vs. number of customers) are given.

Baskin, H., Borgerson, B., Roberts, R., "PRIME--A Modular Architecture for Terminal Oriented Systems", AFIPS SJCC 40, 1972, pp. 431-437.
[Operating System, Multi-processing, Security, Error Detection, Error Recovery, Time Sharing, Computer Hardware, Reliability]

In this system a basic assumption is that failures exist as a normal occurence, rather than a special state, and they must be treated while continuing as near normal operation as possible. PRIME is a modular, canonical system consisting of n identical subsystems which can process n independent jobs with a high degree of protection from each other.

Baskin, H., Horowitz, E., Tennison, R., Rittenhouse, L., "A Modular Computer Sharing System", CACM 12, Oct. 1969, pp. 551-559.
[Operating System, Multi-processing, Security, Error Detection, Error Recovery, Time-sharing, Computer Hardware]

The system organization used is a bank of interchangeable computers, each consisting of a memory/processor pair, which are assigned to process terminal jobs as they arrive. One computer serves as master and supervises collection and distribution of messages from and to remote terminals. In simplest form, each computer has associated with it a disk drive assigned under control of the master computer.

Baum, R.I., Hsiao, D.K., "A Semantic Model for Protection Mechanisms in the Data Base System", Eighth Hawaii Int'l. Conf. on System Sciences, 1975, pp. 175-179.
[Access Control, Data Security]

Given a data base, the relationships which exist between items in the data base, and the fact that a certain user is not to gain knowledge of certain items, this paper presents a variety of protection methods which vary in complexity of implementation and the total amount of information withheld.

Belsnes, D., "Flow Control in Packet Switching Networks", InterNetwork Working Group Note #63, Oct. 1974.
[Flow Control, Packet Communication, Congestion]

A discussion is given of the window scheme, an end-to-end untested flow control mechanism, and their possible advantages to a network.

Benoit, J.W., Graf-Webster, E., "REX--A Resource Location and Acquisition Service for the ARPA Computer Network", MITRE Technical Report #387, January 1974, MITRE Corp., McLean, Va.
[ARPANET, Command Language, Distributed Computing, Documentation, Network Accounting, On-line Documentation, Resource Sharing]

Several existing resource sharing systems on the ARPANET are briefly described, and some basic needs of a resource sharing system are discussed. The REX system is described. REX is a system which allows a user to locate a desired resource on the net. This is done using local files. No host-host communication is required.

Bensoussan, A., Clingen, C., Daley, R., "The MULTICS Virtual Memory", ACM Second Symposium on Operating Systems Principles, October 1969, pp. 30-42.
[MULTICS, Virtual Memory, Access Control, Data Sharing, Segmentation, Paging, Address Space]

Design and implementation considerations of segmentation and paging in MULTICS are discussed in detail. It is shown how the MULTICS supervisor, in conjunction with the GE 645 segmentation and paging hardware, utilizes the virtual memory.

Bernstein, A., Detlefsen, G., Kerr, R., "Process Control and Communication", ACM Second Symposium on Operating Systems Principles, October 1969, pp. 60-66.
[Interprocess Communication, Process Control, Co-operating Processes]

The structure of processes within a general purpose operating system and primitives available for process control and inter-process communication are described.

Berra, P.B., "Some Problems in Associative Processor Applications to Data Base Management", AFIPS Conf. Proceedings 43, 1974, pp. 1-5.
[Associative Memory]

This is a brief, up-to-date review of research into associative devices and their application to handling data bases.

Betourne, C., Boulenger, J., Ferrie, J., Kaiser, C., Kott, J., Krakowiak, S., Mossiere, J., "Process Management and Resource Sharing in the Multiaccess System 'ESOPE'", ACM Second Symposium on Operating Systems Principles, October 1969, pp. 67-74.
[Resource Sharing, Process Control, Process Synchronization, File System Design, Virtual Memory, Resource Allocation]

Process management, virtual memory, file system organization, memory allocation, and user scheduling are discussed generally in relation to the main design principles of the multiaccess system ESOPE. No actual implementation details are given.

Bhushan, A., "Data and File Transfer--Some Measurement Results", RFC 573, Sept. 1973.
[File Transfer Protocol, Network Measurement]

This RFC describes results of file transfer measurements on the ARPANET between the MIT-DMS system (a PDP-10) and five other PDP-10's on the network (with either TENEX or ITS operating systems). The measurements are primarily of transfer rate, response time, cost, and availability.

Bhushan, A., Braden, R., Crowther, W., Harslem, E., Heafner, J., McKenzie, A., Melvin, J., Sundberg, R., Watson, R., White, J., "The Data Transfer Protocol", RFC 264, NIC 7812, Nov. 1971.
[Data Transmission, Protocol, Remote Job Entry]

Although it would be possible to include some or even all applications in an all-inclusive file transfer protocol, a separation between data transfer and application functions may provide flexibility in implementation, and reduce complexity. The authors have defined a data transfer protocol (DTP) which should be used for transfer of all data in file transfer, remote job entry, and other applications protocols.

Bhushan, A., Ryan, N., "Using MIT-MATHLAB MACSYMA from MIT-DMS MUDDLE--An Experiment in Automated Resource Sharing", NIC #19501.
[Automated Resource Sharing]

This paper describes an experiment in nontrivial automated resource sharing between the MUDDLE system at MIT-DMS and the MACSYMA system at MIT-MATHLAB in such a manner that the MUDDLE-user is not required to know anything about the ARPA Network, MATHLAB, or even MACSYMA.

Blanc, R., "Availability and Usability of Computer Communication Networks", Seventh Hawaii International Conference on System Sciences - Subconference on Computer Networks, 1974.
[Distributed System, Front-end Processor, Remote Job Entry]

This paper presents a general survey of some considerations in network evaluation and selection.

Blanc, R.P., "Review of Computer Networking Technology", NBS Technical Note 804, National Bureau of Standards, Jan. 1974.
[Network, TYMNET, CYBERNET, GE Information Services, MERIT, ARPANET, TSS Network]

This report gives a short overview and description of current network Technology, then describes and performs cursory analyses of several existing networks.

Bloom, B.H., "Some Techniques and Tradeoffs Affecting Large Data Base Retrieval Times", Proceedings ACM Twenty Fourth National Conf., 1969, pp. 83-95.
[Data Structuring, File System Design, Retrieval Strategies]

An analysis of retrieval-time savings from the use of inverted files is given. The corresponding increase in update time and the further savings that may be accomplished by compression of the inverted file are also discussed.

Bolt, Beranek, and Newman, Inc., "Specifications for the Interconnection of a Host and an IMP", Report #1822, Bolt, Beranek, and Newman, Inc., Cambridge, Ma.
[Protocol, IMP, IMP-Host Protocol, Host-IMP Protocol, Communications Equipment, ARPANET, Packet Communication]

This report describes the physical, hardware, and software environment a computer site must establish to connect to the ARPANET via a BBN Interface Message Processor. IMP-HOST and HOST-IMP message leader formats are described for the implementer of HOST-IMP communications software. Hardware interface specifications are given for the implementer of interface hardware. This document is periodically updated to reflect hardware/software changes in the IMP.

Booth, G.M., "The Use of Distributed Data Bases in Information Networks", First Int'l. Conf. on Computer Communication, 1972, pp. 371-376.
[Distributed System, Data Management Overview]

This paper talks about problems associated with several aspects of distributed data bases, as well as various solutions to those problems and implications of the solutions.

Bouknight, W.J., Grossman, G.R., Grothe, D.M., "The ARPA Network Terminal System: A New approach to Network Access", Center for Adv. Comp., Univ. of Ill., Urbana, Ill.
[ARPANET, Front-end Processor, Operating Systems]

This paper describes an operating system developed for a PDP-11 as an access medium to the ARPANET. The layered system uses a line-switched oriented interprocess communication method between special processes designed to handle multiple users in a unique way.

Braden, R., "Interim NETRJS Specifications", RFC 189, NIC 7133, July 1971.
[Data Transfer, Protocol, NETRJS]

This document describes the operation and protocol of the remote job entry service to CCN's 360 model 91. The interim protocol described will be implemented as a production service and it will be superseded in a few months by a revised NETRJS which would bring the data transfer protocol of NETRJS into complete conformity with the proposed Data Transfer Protocol (DTP).

Bressler, R., "Interprocess Communication on the ARPA Computer Network", MIT Civil Engineering MS Thesis, June 1971.
[Inter-process Communication, Co-operating Processes, Resource Sharing, Time Sharing, IMP, NCP, Socket, Flow Control, ARPANET]

The development of a Network Control Program (NCP) for the ITS PDP-10 timesharing system is outlined. The relationship between the I/O structure of a time sharing system and the network as an I/O device is defined. Finally, the control commands and the choice of sockets as the mapping device for the link space is examined and suggestions for improvement in the NCP are given.

Bressler, R., "Free File Transfer", RFC 487, Apr. 1973.
[Access Control, Accounting, FTP, Security]

This RFC discusses briefly an access control and accounting problem inherent in a network where each host does its own user validation. Also see RFC's 501 and 505.

Bressler, R., Guida, R., McKenzie, A., "Remote Job Entry Protocol", RFC 407, Oct. 1972.
[Protocol, FTP, RJE, NETRJS]

This document defines the present ARPANET RJE protocol. The document is slightly inaccurate in that it has not been revised to conform to the newer FTP (see RFC's 542 and 460) and is based on the older FTP described in RFC 354. This protocol provides a good example of what a network RJE facility should provide.

Bressler, R., Murphy, D., Walden, D., "A Proposed Experiment with a Message Switching Protocol", RFC 333, NIC 9926, May 1972.
[Message Switched Protocol, Protocol, Communications, Host-Host Protocol, NCP]

A message switching protocol (MSP) is a system whose function is to switch messages among its ports. The authors propose, as an aside to network development using the current NCPs, to rethink the design of NCP-level software beginning with a consideration of MSPs. The organization of the lowest level host-host protocol in the ARPA Network around MSPs, and how this organization would affect the implementation of host software, is described.

Bressler, R., Thomas, R., "Inter-Entity Communication--An Experiment", RFC 441, Jan. 1973.
[Resource Sharing, User Support]

This paper describes highly successful early attempts on the ARPANET to develop techniques of user-user communication. The experiment allowed a user to "find" another user if he was on any other machine on the network participating in the experiment. He was also able to talk to the user, show the user what he was doing, etc. The experiment was performed between the PDP-10 at MIT-DMCG and the various PDP-10 TENEX systems.

British Post Office, "Experimental Packet Switched Service", Issue 3, January 1974.
[Packet Communication, Protocol, Distributed System, EPSS]

A detailed specification of the British Post Office experimental packet switched data communication service is given.

Browne, P., Steinauer, D., "A Model for Access Control", ACM SIGFIDET Workshop on Data Description, Access and Control, 1971, pp. 241-262.
[Access Control, Resource Sharing, Authorization, Protection]

The problems of authorization for a multiple-user resource sharing data processing system are discussed. The requirements for the access of objects (e.g., terminals, users, programs, etc.) to other objects are covered in some detail. A model for access control is developed which combines the military-type level (tree-structured) classification and a category or clique classification. No discussion is given of efficiency, issues of identification, or other advantages and disadvantages of the model.

Casey, R.G., "Design of Tree Networks for Distributed Data", AFIPS Conference Proceedings 42, 1973, pp. 251-257.
[File Allocation, Network Topology]

This paper combines techniques for network design and Casey's file allocation algorithm (Casey, 1972) into a single algorithm for design of the network and allocation of the files, when information on data bases and their usage is known in advance.

Cerf, V., "The Current Flow-Control Scheme for IMPSYS", RFC 442, NIC 13774, Jan. 1973.
[IMP, Flow Control, Communications Subsystem, ARPANET, Traffic Control]

The ARPANET IMP flow control as of Jan 1973 is presented in an understandable form. The control was intended to eliminate unnecessary retransmissions of packets when the net is under heavy load and to increase net bandwidth. The strategy involves multiple acknowledgements piggy-backed onto data packets between two IMPS.

Cerf, V., "An Assessment of ARPANET Protocols", RFC 635, Apr. 1974.
[IMP-IMP Protocol, Host-Host Protocol, Network Performance]

This paper discusses some of the theoretical and practial aspects of the ARPA IMP-IMP and Host-Host protocols. Of major importance are problems such as packet re-assembly, retransmission, and duplicate detection. The author makes recommendations for new protocols based on past experience.

Cerf, V., Dalal, Y., Sunshine, C., "Specification of Internet Transmission Control Program", Inter Network Working Group Paper #72, 1974.
[Host-Host Protocol, IPC, Flow Control]

This paper provides a detailed description of the Internet protocol and the control program necessary to implement it. The paper covers the problems of reconnection, flow control, and measurement in the environment of the new protocol. The document is a guide to implementers of the protocol.

Cerf, V., Kahn, R., "Host and Process Level Protocols for Internetwork Communication", Inter Network Working Group Draft Report, July 1973.
[Host-Host Protocol, Flow Control, Reliability]

This paper describes the inter-network protocol developed by the inter-network working group. The protocol provides clean handling of process-process communication and flow control. It can best be described as a hybrid message-switch protocol.

Cerf, V., Naylor, W., "Selected ARPA Network Measurement Experiments", Proc. IEEE COMPCON/2, 1972, pp. 201-204.
[ARPANET, Routing, Flow Control]

This paper analyzes the cost of multipacket message re-assembly in the ARPANET IMP. This paper represents an argument for the reservation of the correct number of re-assembly buffers in the destination IMP.

Chambers, J.M., "A User-controlled Synchronization Method", IBM SIGOPS, 1974, pp. 16-25.
[Deadlock Prevention, Process Synchronization]

This paper discusses a method of inter-process communication by which processes can request resources, find out whether those resources have been received, and detect deadlock without ever necessaily being blocked. This allows the processes to possibly take alternative actions when the requested resources are not currently available.

Chandler, A., Adams, C., Barry, P., Dewis, I., Hammond, N., Higginson, P., John, R., Olejniczak, J., "Report of the Higher Level Protocol Working Group", InterNetwork Working Group Protocols Note #6, Aug. 6, 1974.
[Protocol, EPSS, Interactive Terminal Protocol, FTP, RJE, Data Transfer Protocol]

Specifications are given for four high level protocols--Interactive Terminal Protocol (ITP), File Transfer Protocol (FTP), Remote Job Entry Protocol (RJE), and Data Transfer Protocol (DTP)--for the Experimental Packet Switched Service (EPSS).

Chandra, A.N., "Some Considerations in the Design of Homogeneous Distributed Data Bases", Proc. IEEE COMPCON73, 1973, pp. 185-186.
[Distributed System, Data Management Overview]

This paper briefly discusses many of the problems associated with the design of a distributed data base which is to reside on a homogeneous network.

Chesson, G.L., "Communication and Control in a Cluster Network", Proceedings ACM, 1974, pp. 509-514.
[Interprocess Communication]

A communications scheme for an interconnected network of processors typified by short-delay communications, local memory, and software controlled scheduling, resource allocation, and interprocess communication, is described. The scheme permits a program to use all the available multiprocessing power it needs while yielding the same results if operated with one processor.

Chu, W.W., Ohlmacher, G., "Avoiding Deadlock in Distributed Data Bases", Proc. ACM, 1974, pp. 156-160.
[Access Control, Data Base Integrity, Deadlock Prevention, Distributed System]

This paper discusses three methods of deadlock prevention or detection based on availability of prior knowledge of file use by a process, and whether files are pre- or demand-allocated. Ways of implementing all three techniques on a distributed network are presented.

Cocanower, A., "MERIT Computer System: Software Considerations", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 65-77.
[Traffic Control, MERIT, Process Synchronization, Inter-process Communication, Communications Processor, Front End Processor, Multi-tasking, Semaphores]

The programming considerations for the MERIT Computer Network are described briefly with respect to host and communication computer philosophy, organization, component description and function, operating system design, and traffic regulation. Implementation difficulties and potential user problems are discussed.

Collier, W.W., "Asynchronous Interactions on Shared Data", IBM SIGOPS, 1974.
[Deadlock Prevention, Process Synchronization]

If the hardware on which a program is to be run has uninterruptable instructions for manipulating the memory referenced by two processes, then those processes can be written so that they can both reference memory without hindering each other.

Computer Communications Group, "Datapac Standard Network Access Protocol", Trans-Canada Telephone System, Nov. 1974.
[Host-Host Protocol, Imp-Host Protocol, Datapac]

This paper discusses in detail the characteristics of the node to host and host to host protocols in the Bell Canada Datapac network.

Cotton, I., "Network Management Survey", Seventh Hawaii International Conference on System Sciences - Subconference on Computer Networks, 1974.
[Network Management, ARPANET, MERIT, TYMNET]

A brief comparison in table format is presented of management practices for the ARPANET, MERIT, TUCC, Oregon State, and Tymnet networks. All information is from reference material.

Crocker, S., Heafner, J., Metcalfe, R., Postel, J., "Function-oriented Protocols for the ARPA Computer Network", AFIPS SJCC, 1972, pp. 271-279.
[ARPANET, Protocol, Interprocess Communication]

A brief description is given of low level protocols which make up the communications subnet of the ARPANET. The use of remote interactive systems through high level function-oriented protocols--such as FTP, TELNET, and RJE--is discussed.

Crowther, W., Heart, F., McKenzie, A., McQuillan, J., Walden, D., "Report on Network Design Issues", InterNetwork Working Group Note #64, Oct. 31, 1974.
[Flow Control, Store and Forward Networks, Network Interconnection, Network Design, Packet Communication, ARPANET, Deadlock]

Packet switching design issues--design requirements; message processing by the subnet; single packet messages only; packet size; lock-ups; interreference; and other bugs and short comings--are discussed, especially as they relate to the ARPA Network.

Daley, R., Dennis, J., "Virtual Memory, Processes, and Sharing in MULTICS", CACM 11, May 1968, pp. 306-312.
[MULTICS, Virtual Memory, Data Sharing, Dynamic Linking, Multi-programming, Storage Management, Storage Hierarchies, Resource Sharing, Security]

Basic concepts involved in the design of the MULTICS operating system, such as processes, address space, and virtual memory, are introduced and defined. Procedure and data sharing is discussed and the dynamic transformation of symbolic references into virtual machine addresses is described in detail.

Davidson, J., "An Echoing Strategy for Satellite Links", RFC 357, NIC 10599, June, 1972.
[Satellite Communication, Telnet Protocol]

This document is a description of a technique for reducing the apparent echoing delay experienced by terminal users when the echoing is being performed over a long-delay, e.g., satellite path. These ideas were essentially implemented in the second version of the ARPANET TELNET protocol (Remote Controlled Transmission and Echoing Option).

Davies, D., "The Principles of a Data Communication Network for Computers and Remote Peripherals", IFIPS 68, North Holland Pub Co., 1969, pp. 709-715.
[Store and Forward Networks, Packet Communication]

An outline for a store-and-forward common-carrier data network is proposed.

Davies, D., Bartlett, K., Scantlebury, R., Wilkinson, P., "A Digital Communication Network for Computers Giving Rapid Response at Remote Terminals", ACM Symposium on Operating System Principles, October 1967.
[Store and Forward Networks, Common Carrier Data Network, Network Design, Packet Communication, Time Sharing]

A design for a common-carrier data network is described. Topics include link design, node design, message transmission, software organization, network performance estimates and node performance estimates.

Davies, D.W., Barber, D.L.A., "Communication Networks for Computers", John Wiley and Sons, 1973.
[ARPANET, Communications, Error Detection, Error Recovery, Flow Control, Network Bandwidth, Network Design, Packet Communication Analysis, Routing]

A comprehensive text dealing with most aspects of computer networks from the basic communications hardware up to network software. The detail is severe on some data communications techniques.

Desautels, E., Chow, V., Schneider, M., "Loosely Coupled Systems", Computer Sciences Technical Report #187, University of Wisconsin at Madison, July 1973.
[Front-end Processor, Time Sharing, Intelligent Terminal]

An outline is given of a current investigation into costs and benefits of coupling a small time sharing system to a large multi-programmed system. Directions of research include the use of the small system as an "intelligent" terminal or a front-end processor.

Despres, R., Guinaudeau, P., "RCP--The Experimental Packet-Switched Data Transmission Service of the French PTT", Inter Network Working Group General Note #67, Aug. 1974.
[Packet Communication, Store and Forward Networks, Virtual Memory Flow Control]

An experimental packet-switched data transmission network, based on the use of virtual circuits, is described. Detailed information is given on the network hardware configuration, network commands, and protocols for virtual circuit switching.

Deutsch, P.L., "Cross-country Network Bandwidth", RFC 567, NIC 18970, Sept. 1973.
[ARPANET, Traffic Analysis, Network Bandwidth]

This paper presents a very brief analysis attributing network peak loads to the undue delays in the cross country echoing of characters over ARPANET.

Dijkstra, E.W., "Hierarchical Ordering of Sequential Processes", Acta Informatica 1, Springer-Verlag, 1971, pp. 115-138.
[Multi-programming, Process Synchronization, Interprocess Communication]

This paper introduces the concept of "layered" design of operating systems. It then discusses the semaphore, a mechanism used by "virtual machines" or processes to guarantee mutual exclusion from critical sections and effect synchronization of "consumers" and "producers" of a consumable resource. A problem of mutual exclusion called the "five dining philosophers" is discussed and a solution proposed.

Dijkstra, E.W., "A Class of Allocation Strategies Inducing Bounded Delays Only", AFIPS SJCC, 1972.
[Resource Sharing, Multi-programming, Process Synchronization]

A set of conditions and an allocation strategy are presented that prevent starvation in any of a set of processes competing for a set of resources.

Dijkstra, E.W., "Co-operating Sequential Processes", Programming Languages, F. Genuys, ed., Academic Press, New York 1968.
[Resource Sharing, Multi-programming, Process Synchronization, Interprocess Communication, Semaphore]

This paper describes the general problems encountered by co-operating sequential processes and some specific solutions. A set of primitives to effect co-ordination between co-operating sequential processes is motivated and developed. These primitives, the P and V operations on an object called a semaphore, are discussed in detail with examples. Co-operation using status variables, with semaphores providing mutual exclusion, to permit more arbitrary co-ordination than semaphores allow is also described. Finally, the banker's algorithm, a deadlock prevention scheme, is motivated and described.

Engles, R.W., "A Tutorial on Data Base Organization", Annual Review in Automatic Programming, Vol. 7 Part I, 1972, pp. 1-64.
[File System Design, Data Independence, Data Structuring]

The first section of the report is an introduction, which includes data management history, trends, and terminology; the second section presents a theory of operational data based on the notions of entity sets and data maps; the third section is an exposition of data base design, emphasizing structure, search, and maintenance; the fourth section shows why data independence is a necessary feature of a viable data base system.

Fabry, R.S., "Dynamic Verification of Operating System Decisions", CACM 16, Nov. 1973, p. 659.
[Operating System, Data Security, Error Detection, Protection]

A description of Berkeley's PRIME system is given. Protection against "leakage" of data due to operating system failure is provided by software-firmware redundancy. Key decisions (e.g., process creation, page allocate/deallocate, messages) made by software must go through, and be verified by, the firmware.

Farber, D., "Networks: An Introduction", Datamation 18, April 1972, pp. 36-40.
[Network]

This article gives an overview of this expanding field by examining seven typical networks: ARPA, CYBERNET, DCS, MERIT, OCTOPUS, TSS, and TVCC.

Farber, D., "Data Ring Oriented Computer Networks", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 73-93.
[Distributed System, DCS, Error Detection, Error Correction, Process Synchronization, Ring Network]

A general discussion of broadband communications systems, with a detailed discussion of a particular distributed system known as a data ring, is presented in the context of its application to computer networks. The functional advantages as well as the technical difficulties in the implementation and use of the data ring are discussed. (author abstract)

Farber, D., Larson, K., "The System Architecture of the Distributed Computer System--The Communications System", Computer Communications Networks & Teletraffic, J. Fox, ed., 1972, pp. 21-27.
[DCS, Distributed System Technology, Broadcast Mode, Protocol, Error Detection, Error Correction, Ring Network]

The Distributed Computer System (DCS) is a data communications ring. The communications protocols are described and the advantages are given for addressing mesages to processes, removing a message from the ring only at the originating Ring Interface, and message sequencing. Error detection and correction are also discussed.

Farber, D., Larson, K., "The Structure of a Distributed Computing System--Software", Computer Communications Networks and Teletraffic, J. Fox, ed., 1972, pp. 539-545.
[DCS, Ring Network, Protocol, Distributed Network Technology, Inter-process Communication, Process Synchronization, Ring Protocols]

A general description of the design goals and hardware topology of the Distributed Computing System (DCS) is given. It is shown how they shaped the operating system. A description is given of the level structure of the operating system. Future plans for the network are presented.

Farber, D.J., "The Structure of a Distributed Computer System--The Distributed File System", First Int'l Conf. on Computer Communications, Oct. 1972, pp. 364-370.
[Distributed System, File System Design, Network, DCS]

The DCS is a distributed computer system in which resource allocation is handled by the processes bartering with one another directly rather than through a central processor. This paper discusses the file system on the DCS, which has properties such that losing any processor does not affect any files not stored on that processor, and moving a file from one processor to another in no way affects the user's view of how to access the file.

Feldman, J.A., Rovner, P.D., "An Algol-Based Associative Language", CACM 12, Aug. 1969, pp. 439-449.
[Content Addressing]

A language in which items are addressed by partial content instead of address is described. Until associative memories become economically feasible, the data structures are implemented using hashing techniques.

Foley, J., Brownlee, E., "A Model of Distributed Processing in Computer Networks with Application to Satellite Graphics", Paper submitted to IFIP Congress, 1974.
[Distributed Computing, Graphics, Time Sharing, Resource Allocation, Modeling]

An optimization model of distributed processing in computer networks is developed with respect to response time.

Fralick, S.C., Brandin, D.H., Kuo, F.F., Harrison, C., "Digital Terminals for Packet Broadcasting", Draft Report, Stanford Research Institute, 1975.
[Packet Radio, Time Sharing, Packet Communications]

This report describes some of the major considerations in the construction of small packet radio terminals. The radio transceiver, processor, and input-output devices are discussed. The Aloha Integrated Control it built at the University of Hawaii and an experimental unit being built at at Stanford Research Institute are discussed.

Frank, H., "Optimal Design of Computer Networks", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 167-183.
[Centralized System, Distributed System, Traffic Analysis, Routing, Network Design]

The design of both centralized and decentralized computer networks is considered, with particular emphasis on layout, link capacity assignment, delay analysis, and network route selection. Both general design problems and specific computational results are discussed.

Frank, H., Chou, W., "Network Properties of the ARPA Computer Net", Networks 4, John Wiley & Sons, Inc., 1974, pp. 213-239.
[ARPANET, Network Bandwidth, Packet Communication Analysis]

This paper starts with an overview of ARPA network techniques. Throughput and cost analyses are carried out for a variety of topological, cost, traffic, and line speed criteria. Reliability analyses are also made, with the primary objective of minimizing cost while maintaining reliability.

Frank, H., Chou, W., "Topological Optimization of Computer Networks", IEEE 60, Nov. 1972, pp. 1385-1397.
[Network Design, Network Topology, Centralized System, Distributed Computer Network, ARPANET, Reliability, Network Bandwidth]

Modeling, analysis and design problems, and methodologies for centralized and distributed computer-communication networks are discussed. The basic problem is to specify the location and capacity of each communication link within the network. The design objective is to provide a low-cost network which satisfies constraints of response time, throughput, reliability, and other parameters. (author's abstract).

Frank, H., Frisch, I.T., Chou, W., "Topological Considerations in the Design of the ARPA Computer Network", AFIPS SJCC, 1970, pp. 581-587.
[ARPANET, Network Design, Network Topology, Reliability, Routing, Network]

A design algorithm to establish where links should be established within the ARPA network is given. The algorithm presented obtains a local optimum. Some constraints are included in the decision, such as route selection, capacity assignment, link delay, etc. A graph of cost against throughput is presented to aid in choosing between local optima.

Frank, H., Frisch, I.T., Van Slyke, R., Chou, W.S., "Optimal Design of Centralized Computer Networks", Networks 1, 1971, pp. 43-57.
[Centralized System, Network Topology, Network Bandwidth, Network Modeling, Network Performance Optimization]

A design approach for centralized computer networks is presented. An algorithm to decide link capacities for an arbitrary cost structure is given and an example is studied. An algorithm to find locally optimal topologic solutions for the network is shown and an example given.

Frank, H., Kleinrock, L., Kahn, R.E., "Computer Communication Network Design--Experience with Theory and Practice", AFIPS SJCC 40, 1972, pp. 255-270.
[Distributed System Technology, Message Switching, Network Design, Store and Forward Communications, Resource Sharing, ARPANET, Network Topology, Modeling, Flow Control, Routing, Error Detection, Error Recovery]

Major problems relating to IMP design, topological design, and network modeling on the ARPA network are discussed and the major design techniques which have evolved to deal with them are given.

Gazis, D.C., "Modeling and Optimal Control of Congested Transportation Systems", Networks 4, 1974, pp. 113-124.
[Queueing Theory, Traffic Analysis, Store and Forward Networks]

An approach is discussed for the modeling of congested transportation systems as store-and-forward networks, analogous to communication networks.

Gordon, W.J., Newell, G.F., "Cyclic Queueing Systems with Restricted Length Queues", Operations Research 15, 1967, pp. 266-277.
[Network Modeling, Network Performance, Queueing Network, Queueing Theory, Congestion]

This paper is concerned with stochastic behavior of a system with capacity restrictions. The closed cyclic system considered is shown to be stochastically equivalent to open sysems in which the number of customers is a random variable. Duality is introduced (as holes moving in the opposite direction). Equilibrium equations for several systems are obtained.

Graham, G.S., Denning, P.J., "Protection--Principles and Practice", AFIPS SJCC, 1972, pp. 417-429.
[Security, Protection, Access Control, Domain]

This paper builds upon Lampson's domains (FJCC 1969). An expanded domain scheme using a larger number of types of access is explained in detail, and proven correct. Implementation of the scheme is discussed, including comparisons with several existing operating systems (OS/360, RC 4000, Multics).

Graham, R., "Protection in an Information Processing Utility", CACM 11, May 1968, pp. 365-369.
[Protection, Privacy, Security, Access Control, Data Sharing]

Information processing utility properties which make protection necessary are discussed and the essential properties for a protection scheme are defined. An abstract model of the hardware features and companion software necessary to implement this model are described.

Habermann, A.N., "Synchronization of Communicating Processes", CACM 15, Mar. 1972, pp. 171-176.
[Interprocess Communication, Multi-programming, Process Synchronization]

A formal process synchronization scheme that facilitates correctness proofs of inter-process interaction is described.

Harslem, E., Heafner, J., "Aspects of Large-Scale Resource Sharing through Networks of Computers", Rand P-4833, May 1972.
[ARPANET, Distributed Computing, Resource Sharing]

This paper discusses the desirability of distributed computer networks, and contains a description of ARPANET properties and development. A prognosis is given for network developments in the near future.

Hassing, T., Hampton, R., Bailey, G., Gardella, R., "A Loop Network for General Purpose Communication in a Heterogeneous World", Data Networks: Analysis and Design, DATACOM73, 1973, pp. 88-96.
[Network Topology, Protocol, Security, Data Sharing]

A packet switching data communictions network under development at the National Security Agency for resource sharing and future development of distributed processing and filing systems is described. The network will consist of a hierarchy of interconnected loops or rings, probably based on Bell System T carrier digital transmission technology. Also discussed are the means of nodal connection to the loops, nodal configuration, network protocols, design and security considerations, and implications for the future.

Hayes, J.F., Sherman, D.N., "Traffic Analysis of a Ring Switched Data Transmission System", Bell System Technical Journal 50, November 1971, pp. 2947-2978.
[Traffic Analysis, Network Performance, Ring Network]

This paper is primarily concerned with the analysis of queueing delays in a ring (loop) data transmission system. The results are presented in a set of curves where delay (normalized to units of message length) is plotted as a function of number of stations and source activity. Detailed study is made of the uniform traffic pattern, where each user is identical and communicates equally. A computer simulation was performed and agreed well with the theoretical results.

Herzog, B., "MERIT Computer Network", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 45-48.
[MERIT, Resource Sharing, Front End Processor, Distributed System, Network Design, Network Management]

The objectives and organization of the MERIT Computer Network are discussed from their inception through their projected future development. The historical and administrative compexities are presented. (author's abstract)

Hoffman, L.J., "The Formulary Model for Flexible Privacy and Access Controls", AFIPS 39, 1971, pp. 587-601.
[Access Control, Data Accessing, Privacy]

This paper discusses a method for using a set of procedures to dynamically control access to the information in a data base. This is done in such a way that access can be determined on a per item (rather than per file) basis.

Hsiao, D.K., "A Generalized Record Organization", IEEE Transactions on Computers, C-20, 1971, pp. 1490-1495.
[File System Design, Data Structures]

Working in the context of an example, the author discusses such concepts as field level, occurrence and repetition of an attribute, type and size of values, and keywords, linkages and pointers. He distills from this discussion parameters characterizing records and overall record organization.

Jackson, J.R., "Networks of Waiting Lines", Operations Research 5, 1957, pp. 518-521.
[Network Modeling, Queueing Theory, Queueing Networks]

'A machine shop' is described as a collection of departments, each with exponential service and exponential arrivals from outside the system. The steady-state distribution of the waiting-line lengths for each department is shown to be independent from that for other departments if mean arrival rate is properly defined.

Jackson, P., Stubbs, C., "A Study of Multiaccess Computer Communications", AFIPS SJCC, 1969, pp. 491-504.
[Time Sharing, Analysis, Measurement]

An analytical data stream model, used to describe communications between user and computer, is developed, and a statistical analysis is performed.

Johnson, P.R., Thomas, R.H., "The Maintenance of Duplicate Databases", NIC #31507, Jan. 1975.
[Concurrent Use, Data Base Integrity, Distributed System]

This paper presents a method which (by representing each item in a data base as a quintuple containing information such as time created, time last modified, etc.) allows several distributed computers to maintain multiple copies of a data base in consistent states.

Jones, P.D., "Operating System Structures", IFIP Congress, 1968, pp. 525-530.
[Timesharing, Protection Hierarchy, Centralized Operating System]

Three existing operating systems are reviewed in terms of advantages and disadvantages. A very general description of some basic operating system concepts is given.

Kahn, R., "Terminal Access to the ARPA Computer Network", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 147-166.
[ARPANET, Store and Forward Communications, IMP, Resource Sharing, Time Sharing]

The goals and current developments in the ARPA Network are discussed. The characteristics of a Terminal IMP are described. The Terminal IMP (TIP) will permit direct connection to the ARPA Network.

Kalin, R., "Achieving Reliable Communication", RFC 203, NIC #7168, August 1971.
[Protocol, Communications, Error Detection, Error Recovery]

A non-standard protocol, suitable for either second or third level use, is proposed with the intent of providing error resistant and highly reliable communication channels. Errors introduced by message garbling, message loss, and message pickup are considered. Measures for increasing throughput are also discussed.

Kaye, A., "Analysis of a Distributed Control Loop for Data Transmission", Computer Communications Networks & Teletraffic, J. Fox, ed., 1972, pp. 47-58.
[Data Transmission, Ring Network, Traffic Analysis, Distributed System]

The paper analyzes a loop system for the transmission of fixed length messages in which control is passed around the loop from terminal to terminal. Each terminal has a buffer of one message-length. Analytic formulae for the distribution, mean value, and variance of message waiting time, together with the proportion of blocked messages are obtained. Useful approximations for lightly loaded systems are also given. (author's abstract)

Kleinrock, L, "Survey of Analytical Methods in Queueing Networks", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 185-205.
[Network Topology, Network Performance Optimization, Traffic Analysis, Nodal Blocking, ARPANET]

A brief survey of tools and methods used for the analysis of computer networks is presented. Queueing theory is applied to some simple cases and the results compared with those obtained from simulation and experiment. Discussion of the applicability of queueing analysis is given for more complex cases. (author's abstract)

Kleinrock, L., "Scheduling, Queueing, and Delays in Time-shared Systems and Computer Networks", Computer-Communication Networks, N. Abramson and F. Kuo, eds., Prentice Hall, pp. 95-141.
[Network Performance Optimization, Process Scheduling, Resource Allocation]

This paper consists of two nearly independent mathematical analyses based on queueing theory--the first part is a good review and analysis of the various time sharing scheduling algorithms. The second (and shorter) part discusses network analysis and optimization techniques.

Kleinrock, L., "Research Areas in Computer Communications", Computer Communication Review, SIGCOMM Quarterly Review 4, W. Chu, ed., July 1974, pp. 1-4.
[Communications, Distributed System, Flow Control, Resource Sharing]

The major research areas in computer communications are discussed. The specific problems emphasized by the author are: design of computer communication networks consisting of thousands of nodes, flow control in all networks, and the problems of privacy, security and resource control and allocation in distributed systems.

Kleinrock, L., "Certain Analytic Results for Time-shared Processors", IFIP Congress 68, pp. 838-845.
[Time Sharing, Terminals, Modeling, Queueing Theory, Traffic Analysis]

A basic model for time-shared systems with M consoles is introduced and analyzed. Published measurements on existing computer systems demonstrate the accuracy of the model in describing the behavior of the normalized average response time, taken as the performance measure of these systems. (author's abstract)

Kleinrock, L., "Analytic and Simulation Methods in Computer Network Design", AFIPS SJCC, 1970, pp. 569-579.
[Queueing Theory, ARPANET, Network Modeling, Network Bandwidth, Network Design, Network Performance, Routing]

Analytical techniques are used to analyze computer networks such as the ARPANET. Methods to synthesize an optimal channel capacity assignment are discussed for three different cost functions, including the real life case of the Telpak rates for leased transmission.

Kleinrock, L., Naylor, W., Opderbeck, H., "A Study of Line Overhead in the ARPANET", General InterNetwork Working Group Note #71, Sept. 1974.
[ARPANET, Packet Communication, Flow Control, Network Measurement, Network Performance, Traffic Analysis, Network Performance Optimization, Protocol, Congestion]

Communication channel overhead on the ARPANET is classified into levels of protocol hierarchy and studied for models of system use. Some measurements of line efficiency on the ARPANET are presented and extrapolations to a heavily loaded network are made. Results are derived for a recently suggested replacement for the HOST-HOST protocol and a comparison is made.

Knott, G.D., "A Proposal for Certain Process Management and Intercommunication Primitives", Operating Systems Review 8, Sections 1-6, October 1974, ACM Special Interest Groups on Operating Systems, pp. 7-44.
[Process Control, Interprocess Communication]

The types of process management and intercommunication capabilities found in advanced system implementations (Multics, Tenex, TSS, etc.) and in current operating system theory are characterized. The user-level primitives necessary to support these capabilities are described and some examples are given. An extensive bibliography is also provided.

Lampart, L., "A New Solution of Dijkstra's Concurrent Programming Problem", CACM 17, Aug. 1974, pp. 453-455.
[Semaphore, Critical Section, Concurrent Processes]

A simple solution to the mutual exclusion problem is presented which allows the system to continue to operate despite the failure of any individual component (author's abstract).

Lampson, B.W., "Protection", Proc. Fifth Princeton Symposium on Information Sciences and Systems, March 1971, pp. 437-443.
[Access Control, Security]

Abstract models are given which reflect the properties of most existing mechanisms for enforcing protection or access control, together with some possible implementations. The properties of existing systems are explicated in terms of the model and implementations. (author's abstract)

Lampson, B.W., "Dynamic Protection Structures", AFIPS FJCC, 1969, pp. 27-38.
[Security, Protection, Access Control, Domain]

This paper describes domains, or the set of capabilities (access rights) of a process. Most aspects of protection are discussed in this context, including passing permissions between domains, transfer of control between domains, and proprietary programs (mutually suspicious subsystems).

Lay, W., Mills, D., Zelkowitz, M., "Design of a Distributed Computer Network for Resource Sharing", AIAA Computer Network Systems Conference, Paper #74-426, 1973.
[Distributed Computing, Resource Sharing, Time Sharing, Fault Tolerance, Kernel, Virtual Memory, Interprocess Communication, Message Switching, Resource Management, Ring Network]

A distributed operating system for an integrated network of non-homogeneous minicomputers is proposed. Current distributed computer network designs are discussed. The general organization of the prototype Distributed Computer Network (at the University of Maryland) including storage management, interprocess communication (via messages and ports), and resource management is discussed.

Lefkovitz, D., "File Structures for On-line Systems", Spartan Books, 1969.
[File System Design, Retrieval Strategies]

This is a basic text on information systems. It includes chapters on directory decoding, file organization, file update and maintenance, etc.

Linde, R.R., Gates, R., Peng, T., "Associative Processor Applications to Real Time Data Management", AFIPS 42, 1973, pp. 187-195.
[Associative Processing]

This paper evaluates the comparative advantages of associative processing over conventional sequential processing as applied to data management functions and in particular the data management functions of the U.S. Air Force Tactical Air Control Center.

Loomis, D., "Ring Communication Protocols", Technical Report #26, Dept. of Information and Computer Science, University of California at Irvine, January 1973.
[Protocols, Message Transmission, Distributed Control, Ring Network]

A number of schemes for coordinating message transmission among computing components which are connected together by a single unidirectional, continuous and circular communication channel are discussed. The paper also examines mechanisms using distributed control to allow message transmission by node without interference from each other.

Luther, W., "Conceptual Bases of CYBERNET", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 111-146.
[CYBERNET, Time Sharing, Remote Job Entry, Store and Forward Communications, Distributed System, Message Switching]

This paper is a detailed description of CYBERNET--a currently operating, extensive, commercial network. The communication facilities and particular hardware configurations are described in detail. A discussion of the computer as a public utility is also included. (author's abstract)

Mader, E., "A Protocol Experiment", RFC 700, Aug. 1974.
[Host-Host Protocol, Network]

This paper discusses an implementation of the Internet protocol between a Tenex and PDP-11 at BBN. A discussion of some extensions to the protocol and the difficulties encountered is presented along with a theoretical analysis of the bandwidth capabilities of the protocol.

Mader, E., "Network Debugging Protocol", RFC 643, July 1974.
[Protocol, Debugging, User Support]

This document describes a protocol to implement a cross-net debugger for PDP-11's. The protocol bypasses the standard Host-Host protocol and assumes the remote machine is capable of performing low level debugging tasks.

Madnick, S.E., Alsop, J.W., "A Modular Approach to File System Design", AFIPS SJCC, 1969, pp. 1-13.
[File System Design]

This paper presents a general model for file system design based on hierarchical "modules" or successive layers of software between user and physical data. The authors note that such modular design should be particularly useful in a network.

McKay, D., Karp, D., "IBM Computer Network/440", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 29-43.
[Distributed System, Telecommunications, Centralized System, Network Control Language]

Network/440 is a heterogeneous, general purpose computer network as well as a research project on networking problems. This paper describes the present design and implementation, and what are forseen as important problems in the field of networking.

McKay, D., Karp, D., "Protocol for A Computer Network", IBM Systems Journal 12, Jan. 1973, pp. 94-105.
[Protocol, Message Switching]

Message processing concepts and a protocol for communications control among network users are discussed.

McKenzie, A., "TELNET Protocol Specification", NIC #18639.
[TELNET Protocol, Protocol, Inter-process Communication, ARPANET]

The ARPANET Network Virtual Terminal (NVT), a canonicalization of the concept of an interactive computer terminal, is defined. The protocol used to communicate with an NVT is referred to as TELNET. This document describes the basic form of "negotiated options", the mechanism used to modify NVT behavior with respect to echoing, format effectors, etc. Particular options are defined in separate papers. This document is the TELNET reference document and may be updated or superseded at some future date.

McKenzie, A., "Host/Host Protocol for the ARPA Network", NIC #8246.
[Host-Host Protocol, Protocol, Inter-process Communication, ARPANET]

This document explains the philosophy of the host-host inter-process communication protocol used in the ARPA network. It then explains in detail the operations that must be performed to implement the protocol. This is the reference document for this protocol and is periodically updated.

McKenzie, A.A., Cosell, B.P., McQuillan, J.M., Thorpe, M.J., "The Network Control Center for the ARPA Network", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[ARPANET, Network Control, Network Management]

The NCC is responsible for detecting, locating, and correcting failures in the ARPANET IMP communications network. This paper discusses the hardware and software used to accomplish this, along with several measurement facilities.

McQuillan, J., "Response to RFC 567-Cross Country Network Bandwidth", RFC 568, NIC 18971, September 1973.
[ARPANET, IMP, Bandwidth, Flow Control, Traffic Analysis]

Many salient points omitted in RFC 567 are underscored. The reason for tardy character echoing is attributed to delay in the hosts and subnet instead of bandwidth.

McQuillan, J., Crowther, W., Cosell, B., Walden, D., Heart, F., "Improvements in the Design and Performance of the ARPA Network", AFIPS FJCC, 1972, pp. 741-754.
[ARPANET, IMP, Network Design, IMP-IMP Protocol, Flow Control, Store and Forward Networks, Packet Communication, Network Measurement, Network Performance Optimization, Congestion, Deadlock]

New algorithms in the areas of source-to-destination sequence control, source-to-destination flow control, and IMP-to-IMP transmission control are given as a result of the discovery of logical flaws in the interface message processor (IMP) software. Changes in program structure are discussed. Measurements of network throughput, IMP reliability, and IMP performance are given.

Mendicino, S., "OCTOPUS: The Lawrence Radiation Laboratory Network", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 95-110.
[Centralized System, OCTOPUS, Distributed System, Data Transmission]

The evolution of the Lawrence Radiation Laboratory Livermore OCTOPUS from a centralized network to a distributed one, consisting of a superimposition of specialized sub-networks, is described.

Metcalfe, R., "Packet Communication", Rpt. #MAC TR-114, Project MAC, MIT, Dec. 1973.
[Protocol, Packet Communication, ARPANET, ALOHA, Network Bandwidth, Interprocess Communication, Thin-line Communications, Satellite Communication]

This report develops a theory of packet communication: it analyzes uses of computers in digital communication systems and examines structures for organizing computers in highly communicative environments. Various examples from existing computer networks are used to motivate and substantiate analysis of store-and-forward packet communication, broadcast packet communication, and distributed interprocess communication. Bandwidth, protocols, inter-node spacing, packet lengths, and other aspects of packet communication are examined from the standpoint of underlying theory.

Metcalfe, R., "Strategies for Interprocess Communication in a Distributed Computing System", Computer and Communications Networks and Teletraffic, J. Fox., ed., 1972, pp. 519-525.
[ARPANET, Protocol, Routing, Error Recovery, Interprocess Communication, Message Switching, Distributed System Technology, Ports]

Characteristics are given for distributed and centralized systems processes and protocols. Thin-wire (distributed) interprocess communication is explained and it is suggested that it should be used more generally in computer operating systems for reliability reasons.

Miller, E.F., Pritchard, E.L., "Process Control and File Management in Large Minicomputer Networks", Proc. IEEE COMPCON73, 1973, pp. 199-201.
[Computer Networks]

A proposal for providing a "floating" operating system (BOSS) which delegates authority as needed to "junior executives" (JEXs). "The study of the requirements for the control program(s) and the data management functions is anthropomorphic." A hierarchical structure similar to that of large companies is recommended for large minicomputer networks. Reliability problems with hierarchical structure in a distributed environment are not addressed.

Miller, T.J., "Deadlock in Distributed Computer Networks", Rpt. #UIUCDCS-R-74-619, Dept. of CS, Univ. of Ill., Urbana, Dec. 1974.
[Deadlock, Process synchronization]

This paper discusses deadlock detection in a centrally controlled environment, in which a single resource manager performs allocation, and in a distributed control environment, in which processes perform their own resource allocation. Shared memory for residence of Dijkstra semaphores and other data structures are assumed, so the title is somewhat midleading.

Morris, J.H., "Protection in Programming Languages", CACM 16, Jan. 1973, pp. 15-21.
[Access Control, Protection]

This paper discusses protection of subprograms from malfunctions of other subprograms. Methods of enforcing user-created type restrictions thru software and restriction of variables to specific programs are discussed.

Moulder, R., "An Implementation of a Data Management System on an Associative Processor", AFIPS 42, 1973, pp. 171-176.
[Associative Processing]

An experimental data management system using an associative processor (AP) is discussed. The database resides on a parallel-head-per-track disk connected to the AP via 72 parallel channels.

Mullin, J.K., "The Specification of Data Structures, Access Methods, and Efficiency ", Proceedings Sixth Annual Princeton Conference on Information Sciences and Systems, 1972, pp. 79-84.
[File System Design, Access Paths, Information System Modeling]

This paper describes a file system simulation program: given information on the data and its structure, as well as retrieval mechanisms and basic costs, retrieval "activities" are simulated and activity costs generated.

Muntz, R.R., "Analytic Models for Computer System Performance Analysis", UCLA Computer Science Department Quarterly 2, Jan. 1974, pp. 49-66.
[Network Performance, Network Modeling, Queueing Theory]

Descriptions of several queueing theoretic models are given (Kleinrock's, Buzen's, Moore's, etc.) and restrictions and future developments are described. Some emphasis is put on the author's model which is the only one with different customer classes.

Needham, R., "Protection-A Current Research Area in Operating Systems", International Computing Symposium, 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1974, pp. 123-126.
[Protection, Security, Access Control, Process Synchronization]

An approach to protection, involving the notion of "regimes of protection" which denote the data a process can access, the variety of access permitted, that selection of other processes it may call, and transitions available to other regimes of protection, is presented. Advantages and disadvantages inherent in the scheme and its implementation are discussed.

Neiger, N., "Comments on CCL", NIC 30071, 1974.
[User Support, Command Language, Network Command Language]

This paper discusses the proposal of the UULP on the ARPANET (see Tentative Proposal for a Unified User Level Protocol). This author sees the main problems as a contention between standardization and resource sharing, and suggests Thomas' view (see Comments on the Common Command Language Effort) as the best solution rather than resolving the contention as Padlipsky proposed.

Neigus, N., "The File Transfer Protocol", RFC 542, July 1973.
[Protocol, FTP]

This document provides the most recent definition of the FTP for the ARPANET. The reader should also be aware of the subsequent RFC 640 on the new reply code structure. FTP provides the means for moving files regardless of internal structure between two hosts.

Opderbeck, H., "Throughput Degradations for Single Packet Messages", RFC 632, NIC 30239, May 1974.
[ARPANET, Flow Control, IMP]

An experiment to measure the bandwidth of single packet message transmission on the ARPANET is reported. Only one fourth of the expected throughput was achieved in many cases. The IMP flow control mechanism is shown to be at fault and two solutions are proposed.

Opderbeck, H., Kleinrock, L., "The Influence of Control Procedures on the Performance of Packet-Switched Networks", Inter Network Working Group Note #62, Sept. 1974.
[Packet Communication Analysis, Deadlock, Error Detection, Error Recovery, Flow Control, ARPANET, Network Performance, Congestion]

The general aims and problems of flow control are discussed as they relate to the ARPANET. Some deadlocks and degradations which have been discovered are discussed.

Padlipsky, M.A., "Specification of the Unified User-Level Protocol", RFC 666, NIC #31396, 1974.
[Protocol, UULP, Time Sharing, Man-machine Communication, ARPANET]

This paper proposes and describes a user-level man and machine usable protocol for standardizing the user interface to time sharing systems. This allows a user or machine to perform many site-independent actions in a site-independent command language. Standardized input conventions and an initial set of commands are described.

Padlipsky, M.A., "A Proposed Protocol for Connecting Host computers to ARPA-like Networks via Front-end Computers", RFC #672, 1974.
[Protocol, ARPANET, Front-end Processor]

This RFC defines a highly flexible protocol for communication between a front-end and a host with significantly less impact on the host than a full NCP in the host. The paper also contains highly relevant "advice" to would-be designers and implementers of network functions.

Padlipsky, M.A., "Comments on CCL.DOC", USING CCL committee paper, 1974.
[Network Command Language, User Support, Command Language]

This paper contains Padlipsky's response to Thomas' comments (see Comments on the Common Command Language Effort). This paper addresses each point of Thomas' paper. This whole series makes good reading for the designer of a network command language.

Padlipsky, M.A., "Two Solutions to a File Transfer Access Problem", RFC 505, July 1973.
[Access Control, Accounting, File Transfer Protocol, Security]

This RFC addresses the problems of file access and accounting for file transfers in a network without network-wide accounting. The author offers two solutions which have been used and discusses their implications (See also RFC's 487 and 501.)

Padlipsky, M.A., "What is 'Free'?", RFC 491, Apr. 1973.
[File Transfer Protocol, Access Control, Security]

This RFC discusses the problems of free system access to provide services such as mail. The problem of the necessity of login is discussed, and several solutions are entertained.

Padlipsky, M.A., "NETED: A Common Editor for the ARPA Network", RFC 569, Oct. 1973.
[Resource Sharing, User Support, Editor]

This document provides a functional description of a common network editor. The editor is based on the Multics editor, EDS. This choice was made because of its simplicity and ease of definition.

Parhami, B., "A Highly Parallel Computing System for Information Retrieval", AFIPS FJCC 41, 1972, pp. 681-690.
[Associative Processing]

A rotating associative processor, RAPID, is described. Design criteria are given along with logic diagrams.

Parhami, B., "Associative Memories and Processors: An Overview and Selected Bibliography", Proc. IEEE 61, June 1973, pp. 722-730.
[Associative Processing]

An overview of hardware and software techniques used with associative memories is given. There are 171 references.

Patil, S.S., "Limitations and Capabilities of Dijkstra's Semaphore Primitives for Coordination Among Processes", Computation Structures Group Memo 57, Project MAC, MIT. Feb. 1971.
[Process Synchronization, Semaphore, Interprocess Communication]

The "cigarette smoker's problem", a representative of a class of coordinations that cannot be performed with Dijkstra's P and V primitives without conditionals, is presented. An extension to the P and V primitives is proposed.

Pogran, K.T., "Unmuddling Free File Transfer", RFC 501, May, 1973.
[Access Control, Accounting, File Transfer Protocol, Security]

This RFC elaborates on the suggestions made in Bressler's RFC 487. The author examines the problem from another point of view and points up several difficulties in security and accounting. Also see RFC's 487 and 505.

Popek, G.J., "Protection Structures", Computer, June 1974, pp. 22-33.
[Access Control, Data Security, Privacy, Protection, Security]

This paper starts with a general discussion of privacy and security. It then surveys control disciplines and protection models in some detail, with numerous references to the literature (84 references).

Popek, G.J., Kline, C.S., "Verifiable Protection Systems", To be presented at the ACM/IEEE Software Reliability Conference in LA, CA., Apr. 1975.
[File System Design, Kernel, Access Control, Data Security, Privacy, Protection, Security, Co-operating Processes, Multi-programming]

This paper primarily describes the UCLA/VM project at UCLA. UCLA/VM is a PDP 11/45-based virtual machine kernel that is verifiable, secure, and a virtualizing package that creates virtual PDP 11/45's.

Popek, G.J., Kline, C.S., "Verifiable Secure Operating System Software", AFIPS NCC, 1974, pp. 145-151.
[Access Control, Data Security, Privacy, Protection, Kernel, Security, Co-operating Processes, Multi-programming]

This paper discusses some aspects of secure operating systems, describes the concepts of security kernels and virtual machines, mentions several difficult security problems, and briefly mentions some aspects of verification of security kernels. The UCLA-VM system, a prototype security kernel and support software for the PDP 11/45, is mentioned briefly. Brief arguments concerning the cost of security are presented.

Postel, J., "Official Initial Connection Protocol", NIC #7101.
[Initial Connection Protocol, Protocol, Inter-process Communication, ARPANET]

This document describes the ARPANET Initial Connection Protocol (ICP), a protocol used to establish an inter-process communication link between two hosts. This is the official ICP document, and may be updated or superseded.

Pouzin, L., "A Proposal for Interconnecting Packet Switching Networks", InterNetwork Working Group Note #60, March 1974.
[Packet Communication, Store and Forward Networks, Gateway, Network Interconnection]

A proposal to allow point to point message transfer across several independent packet switching networks is described. Necessary protocols and possible constraints are discussed.

Pouzin, L., "Presentation and Major Design Aspects of the CYCLADES Computer Network", Proc. Third Data Communication Symp., IEEE, Nov. 1973.
[CYCLADES, Host-Host]

The design of a packet switched network being developed in France is presented. The paper gives a cursory overview to their approach and plans for the future. The approach taken by this group is significantly different from other packet switched networks.

Pouzin, L., "CIGALE, The Packet Switching Machine of the CYCLADES Computer Network", IRIA MIT 556, Nov. 1973.
[CYCLADES, Communication Subsystem, Flow Control, Congestion, Routing]

This paper describes the design of the packet switching nodes of the CYCLADES network. The nodes, French MITRA 15's, implement the routing, flow control and other functions necessary for the maintenance of the communications subnetwork.

Quatse, J., Gaulene, P., Dodge, D., "The External Access Network of a Modular Computer System", AFIPS SJCC 40, 1972, pp. 783-789.
[Resource Sharing, Security, Message Processing, PRIME, Protection, Error Detection, Inter-process Communication]

The PRIME system consists of sets of modules dynamically reconfigured into separate subsystems. Three classes of communications are needed: processor-to-processor, processor-to-facility pool device-(e.g. disk drive), primary memory-to-facility pool device. This paper describes the structure and components of the External Access Network (EAN) developed for this purpose.

Ramamoorthy, C.V., Chandy, K.M., "Optimization of Memory Hierarchies in Multiprogrammed Systems", JACM 17, 1970, pp. 426-445.
[File Allocation, Memory System Design]

The techniques described may be used to determine at what levels files should be stored or to determine the design of the memory hierarchy (given data on file sizes and query frequencies). Mean response time is minimized under a total cost constraint. The algorithms use linear programming and branch-and-bound.

Roberts, L., Wessler, B., "Computer Network Development to Achieve Resource Sharing", AFIPS SJCC, 1970, pp. 543-549. [ARPANET, Resource Sharing, Store-and-forward Networks, Network Topology, Network Design]

This slightly dated article gives the requirements, properties, and topology of the communications system chosen for the ARPANET. A quantitative comparison is made between the chosen ARPANET configuration and alternative network communications systems designs.

Rose, G.A., "Computer Graphics Communications Systems", IFIP Congress 68, North Holland, 1968, p. 692. [Communications, Graphics, Network, Terminal Technology]

Directly-coupled and buffered displays are briefly described. Three experimental systems are compared and discussed: ARDS project, Intergraphic project, IBM 1500 Instructional Display System. Linking of a large number of such devices into a network is discussed.

Rustin, R., "Computer Networks", Prentice-Hall, 1972. [MERIT, OCTOPUS, DCN, CYBERNET, ARPANET, Computer Network]

This book is a series of articles on computer networks which were given at the Courant Institute of Mathematical Sciences at New York University Symposium on November 30-December 1, 1974. Authors and titles are: A. Weis, "Distributed Network Activity at IBM", B. McKay, D. Karp, "IBM Computer Network/440", B. Herzog, "MERIT Computer Network", A. Aupperle, "MERIT Computer Network: Hardware Considerations", A. Cocanower, "MERIT Computer Network: Software Considerations", D. Farber, "Data Ring Oriented Computer Networks", S. Mendicino, "OCTOPUS: The Lawrence Radiation Laboratory Network", W. Luther, "Conceptual Bases of CYBERNET", R. Kahn, "Terminal Access to the ARPA Computer Network", H. Frank, "Optimal Design of Computer Networks", L. Kleinrock, "Survey of Analytical Methods in Queueing Networks". For more complete annotations, see each individual author and title.

Saltzer, J.H., "Protection and the Control of Information Sharing in Multics", CACM 17, July 1974, pp. 338-402. [MULTICS, Security, Privacy, Access Control, Data Sharing, Time Sharing, Virtual Memory, Storage Hierarchies]

Design principles and goals of Multics, a highly secure time-sharing system, are described. The schemes Multics uses to implement the design goals are described in detail, and a discussion of the tradeoffs and weaknesses of the implementation is included. The design principles and access control, authentication, and protection mechanisms discussed in this paper are important concepts in the field of secure operating systems.

Schmid, H., "An Approach to the Communication and Synchronization of Processes", International Computing Symposium 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1973.
[Process Synchronization, Inter-process Communication, Petri Nets, Resource Sharing, Deadlock]

Primitives for the communication of concurrent processes are introduced. Using these primitives, process systems are split into processes independent of, and processes communicating with the environment, which allows easy transformation of process systems into Petri Nets. Finally, the implementation is discussed.

Schroeder, M., Saltzer, J., "A Hardware Architecture for Implementing Protection Rings", CACM 15, March 1972, pp. 157-170.
[Protection, Security, Access Control, MULTICS, Virtual Memory]

Criteria are presented for the design of access control mechanisms, and the processor mechanisms for implementing protection rings are described. Finally, advantages and possible uses for protection rings are discussed.

Schroeder, M.D., "Cooperation of Mutually Suspicious Subsystems in a Computer Utility", Report #MAC TR-104, Project MAC, MIT.
[Security, Access Control, MULTICS]

A protection scheme based on capabilities and protection domains is described. The scheme is efficiently implementable in hardware and extends the methods developed for and implemented by the Honeywell 6180 MULTICS processor. Impacts of the design on the supporting operating system are discussed.

Schwartz, J.T., "Abstract and Concrete Problems in the Theory of Files", Data Base Systems, R. Rustin, ed., Prectice-Hall, 1972, pp. 1-21.
[Data Structuring, Data Accessing, Retrieval Strategies, File System Design]

In this symposium talk given in May, 1971, Schwartz outlined the key problems that should be addressed in developing the area of data base management.

Senko, M.E., "Details of a Scientific Approach to Information Systems", Data Base Systems, R. Rustin, ed., Prentice-Hall, 1972, pp. 143-174.
[Information System Modeling, Information System Measurement, File System Design]

This 1971 Symposium talk is a good, readable introduction to information system modeling in general and Senko's FOREM in particular. (See other papers by Senko et al.)

Senko, M.E., Lum, V.Y., Owens, P.J., "A File Organization Evaluation Model (FOREM)", Information Processing 68, 1969, North-Holland, Amsterdam.
[File System Design, Information System Modeling]

FOREM is a simulation program for a file management system. Given parameters describing logical and physical file layouts, search strategies, file content, and query types, the program generates search-time statistics.

Shneiderman, B., "A Model for Optimizing Indexed File Structures", Int. J. Comp. Inform. Sci. 3, 1974, pp. 93-103.
[Data Structures, File System Design]

Using a graph-theoretic model for data structure and access paths, Shneiderman discusses the minimization of search costs.

Shoshani, A., "Data Sharing in Computer Networks", NIC #12623, Oct. 1972.
[Concurrent Use, Data Sharing, Distributed System, Network]

The author presents several criteria by which to judge a distributed data management system, and then presents and analyzes five such systems. He concludes with some observations he has drawn based on his experience with implementing one of these systems.

Shoshani, A., Bernstein, A.J., "Synchronization in a Parallel-Accessed Data Base", CACM 12, Nov. 1969, pp. 604-607.
[Process Synchronization, Deadlock Prevention, Data Accessing, Data Sharing]

A data base is represented as a directed graph, and then the advatages and disadvantages of several algorithms for parallel access to the data base is discussed in terms of which situations can be handled, which can not, extra information required, and the length of time a node spends locked.

Shoshani, A., Spiegler, I., "The Integration of Data Management Systems on a Computer Network", NIC #15717, 1973.
[Distributed System, Data Accessing]

The authors present a rather extensive overview of the system they designed to act as a front end to several existing data management systems running at various sites on a network.

Slotnick, D.L., "Logic per Track Devices", Advances in Computers, 1970, pp. 291-296.
[Associative Processing]

A head per track disk is described in which each head is capable of boolean operations. This system could be used in applications with a large amount of data and little processing such as scanning the entire disk in one revolution for a match.

Sobolewski, J.S., "Programmable Communication Processors", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[Front-end Processor, User Support, Telecommunications]

This paper surveys the field of communication processors for inquiry and response systems, data collection, conversational computing, remote batch, and message switching systems. The role of minicomputer configurations is explored in each of these areas. The advantages and disadvantages of communication processors is discussed (the primary disadvantage being the lack of manufacturer supported software). This is a decent introductory paper.

Somia, M., "Synchronization Problems in a Computer Network", International Computing Symposium 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1974.
[Resource Sharing, Co-operating Processes, SOC (Systeme d'Ordinateurs Connectes), Process synchronization, Distributed System, Resource Allocation]

Synchronization problems connected with distributed resource allocation are discussed in relation to computer networks, in particular to SOC (Systeme d'Ordinateurs Connectes). The solution implemented is described, and advantages and disadvantages are discussed. Finally, the applicability in more general circumstances is studied.

Sorenson, P., "Interprocess Communication in Real Time Systems", Operating systems Review 7, Oct. 1973, ACM, pp. 1-7. [Interprocess Communication, Message Switching, Data Sharing, Process Synchronization]

Some schemes developed for nonreal-time interprocess communication are reviewed and it is shown they are inadequate for real-time situations. Two models are presented which insure shared data integrity in a real-time situation. The first model involves the control of process scheduling, the second uses multiple copies of data sets. Finally, the notions of real-time independent and dependent data are discussed in reference to real-time communication.

Spier, M., Hastings, T., Cutler, D., "An Experimental Implementation of the Kernel/Domain Architecture", Operating Systems Review 7, Oct. 1973, ACM, pp. 8-21. [Domain, Domain Incarnation, Kernel, Protection]

The conceptual background and framework of a software simulated kernel/domain architecture is described. The need for storage class semantics, which do not exist in current high level languages, is explored. Functional implications, such as the design of a simple CPU scheduler, are given.

Spier, M., Organick, E., "The MULTICS Interprocess Communication Facility", Second ACM Symposium on Operating Systems Principles, October 1969, pp. 83-91. [Inter-process Communication, MULTICS, Co-operating Processes, Process Synchronization]

The MULTICS interprocess communication (IPC) facility is discussed as it relates to capabilities produced as a result of basic system design. Shared data bases by virtue of unambiguous file system names, lock and unlock primitives, and block/wakeup services for processor multiplexing are the basis for the IPC facility.

Spragins, J.D., "Analysis of Loop Transmission Systems", Second Symposium on Problems in the Optimization of Data Communication Systems, 1971, pp. 175-182. [Ring Network, Network Analysis, Queueing Theory]

A queueing theory analysis is performed on loop transmission systems with a single controller and random slot assignment with fixed slot size (the 'lazy suzan'). The paper discusses results of the research effort and emphasis the trade-off considerations in the design of loop systems (buffer size, terminal waiting lines, printer impact, etc.).

Stonebraker, M., "The Choice of Partial Inversions and Combined Indices", Int. J. Comp. Inform. Sci. 3, 1974, pp. 167-188.
[Retrieval Strategies, File System Design, Data Structures]

By characterizing the storage medium and the query set, the author obtains analytic results concerning good indexing strategies. In particular the choice of attributes to be indexed in a partially inverted file and the choice of an optimal subset of combined indices is obtained.

Su, S.Y., Copeland, G.P., Lipovski, G.J., "Retrieval Operations and Data Representations in a Context-Addressed Disc System", Proc. ACM SIGPLAN-SIGIR Interface Meeting, 1974, pp. 144-153.
[Associative Processing]

The advantages of logic per track discs are discussed. These include avoiding the multilevel mappings from high-level retrieval language to machine language and from user oriented data representation to machine oriented data representation.

Summerill, L.F., Kory, M., "Security in Data Management", Eighth Hawaii Int'l Conf. on System Sciences, 1975, pp. 191-194.
[Access Control, Data Security, Security]

This paper briefly discusses many of the various aspects that go into a secure system, ranging from building security guards to aspects of monitoring process activities. Contains some good, short definitions of key phrases.

Summers, R.C., Fernandez, E.B., Coleman, C.D., "Shared Data Access Control with Programming Language Support", Eighth Hawaii Int'l. Conf. on System Sciences, 1975, pp. 187-190.
[Access Control]

This paper describes a method of classifying users, application programs, data items, restrictions based on specific data items, etc., into groups, in a way such that access control can be implemented with only a few changes to a currently existing higher level programing language.

Sunshine, C., "Issues in Communication Protocol Design--Formal Correctness", InterNetwork Working Group Protocol Note #5, Oct. 1975.
[Protocol, Flow Control]

A formal description is given of the failure modes of a simple positive acknowledgement/retransmission protocol with and without sequencing.

Teichroew, D., "An Approach to Research in File Organization", Proceedings of the ACM Symposium on Inform. Stor. and Retr., J. Minke and S. Rosenfeld, eds., 1971.
[File System Design, Information System Modeling]

The thesis of this paper is that research on file organization has not made much progress because the subject is so large and unstructured. The author suggests a structure--that of the Univ. of Michigan Information Systems and Optimization System (ISDOS) project--to be followed.

Thesen, A., "Scheduling of Computer Programs for Optimal Machine Utilization", BIT 13, 1973, pp. 206-216.
[Process Scheduling, Batch Operations, Operating System, Resource Allocation]

An algorithm which yields optimal use of a computer's resources taking into account CPU utilization, memory utilization, priorities, and proximity to deadlines is described. The algorithm is specified for a 360-like batch job environment.

Thomas, R., "A Model for Process Representation and Synthesis", Report #MAC-TR-87, Project MAC, MIT, June 1971.
[Process Representation, Process Synchronization]

The problem of representing groups of loosely connected processes is investigated and a model for process representation useful for synthesizing complex patterns of process behavior is developed. Concepts relevant to the process representation model are defined; a model for process representation is developed; it is shown that the model for process representation is a useful one for synthesizing process behavior patterns. It is suggested how the model could be used as a semantic base for a very potent language extension facility.

Thomas, R., "A Resource Sharing Executive for the ARPANET", BBN Report 2522, March 1973.
[Resource Sharing, User Support]

This describes the RSEXEC system developed for ARPANET TENEX's. The program allows inter-entity functions as described in Bressler's paper (see RFC 441), an environment for file transfer and mail, and maintenance of a list of accessed files.

Thomas, R., "Comments on the Common Command Language Effort", Personal paper to CCL Committee, 1974.
[User Support, Command Language, Network Command Language]

This paper discusses perceived problems with the proposals made in a predecessor of RFC 666. The paper considers the proposal from a different point of view shedding some light on questions such as machine readable versus human readable protocols, resource sharing, etc., and ends with a counter proposal.

van Lamsweerde, A., "Deadlock Prevention in Real Time Systems", International Computing Symposium 1973, A Gunther, B. Levrat, H. Lipps, eds., North-Holland, 1974.
[Deadlock, Process Scheduling, Resource Allocation]

A deadlock prevention scheme that takes job completion times into account is given. The maximum claim and maximum execution of each job is assumed. A dynamic programming formulation is presented and its feasibility discussed.

Walden, D., "A System for Interprocess Communication in a Resource-Sharing Computer Network", CACM 15, April 1972, pp. 221-230.
[Interprocess Communication, Ports, Message Switched Protocol]

A system of communication between processes based on messages is described and the communication system is extended so that it may be used between processes distributed throughout a computer network. the hypothetical application of the system to an existing network is discussed.

Watson, R.W., "Some Thoughts on System Design to Facilitate Resource Sharing", RFC 592, NIC 20391, Nov. 1973.
[Distributed System, Resource Sharing, ARPANET]

An appeal is made to system designers on ARPANET hosts to systemitize interfaces to system services. Decoupling the service from a direct link to the local operating system makes it more accessible to other sites located around the network.

Weis, A., "Distributed Network Activity at IBM", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 1-25.
[RJE, Resource Sharing, TSS, Protocol, Centralized System, Distributed System, Security]

IBM experimental network activities, related to TSS, during 1968- 1972 are described. Some of the outstanding problems that will have to be addressed during the coming years in the area of computer networks are discussed.

Wilkov, R., "Design of Computer Networks Based on a New Reliability Measure", Computer Communications Networks and Teletraffic, J. Fox, ed., 1972, pp. 371-384.
[Network Design, Network Topology, Reliability]

A new criterion for measuring reliability of computer and communications networks based on regular graph theory is suggested. A heuristic iterative procedure, based on this criterion, is given for constructing a maximally reliable network with a specified number of nodes and communications links. Finally, reliabilities of several proposed ARPANET topologies are compared with reliabilities of corresponding topologies derived by the given procedure.

Wodon, P., "Still Another Tool for Synchronizing Processes", Dept. of CS, Carnegie-Mellon Univ., Aug. 1972.
[Process Synchronization, Concurrent Processes, Semaphore]

A synchronizing tool which for some applications is more convenient than the usual semaphore to obtain transparent programs and easy correctness proofs is outlined. The implementation of this new "semaphore" is briefly discussed.

Wulf, W., Cohen, E., Corwin, W., Jones, A., Levin, R., Pierson, C., Pollack, F., "HYDRA: The Kernel of a Multiprocessor Operating System", CACM 17, June 1974, pp. 337-345.
[Operating System, Security, Resource Allocation, Centralized System]

This paper describes the operating system for the Carnegie-Mellon Multi-Mini-Processor. HYDRA is designed to facilitate experimentation, and design goals toward that end are described. The notions of resources, objects, and capabilities are described in detail, and an extended example is given.

Wulf, W.A., Bell, C.G., "C.mmp--A Multi-Mini-Processor", AFIPS FJCC, 1972, pp. 765-777.
[Multi-processing, Process synchronization, Resource Sharing, Operating System, Computer Hardware]

This paper describes a multi-processor configuration of Digital Equipment Corporation PDP-11's being constructed at Carnegie-Mellon University. The processor, memory, and switches being used are described. An operating system kernel called HYDRA is introduced, and a very brief discussion of resources and protection is given. Processor synchronization and related software issues are discussed.

Yue, P.C., Wong, C.K., "Storage Cost Considerations in Secondary Index Selection", IBM Research Report RC 5070, October 1974.
[Data Structures, File Allocation, File System Design]

This paper combines the problem of choosing the best secondary indexes with the problem of best allocating the files to a memory hierarchy in an overall optimization analysis.

Yuen, M., Black, B., Newhall, E., Venetsanopoulos, A., "Traffic Flow in a Distributed Loop Switching System", Computer Communications Networks and Teletraffic, J. Fox, ed., 1972, pp. 29-46.
[Traffic Analysis, Message Switching, Distributed System, Ring Network]

An approximate analytical technique is outlined to calculate statistics for the traffic behavior of a distributed loop switching system under light traffic conditions. Simulation results were obtained from an IBM 370/165 for two separate models of traffic and flow. They agreed closely with those predicted by the statistical model. Finally, it is shown that the system can settle to a steady state even in the most adverse conditions.

Zimmerman, H., Elie, M., "Transport Protocol--Standard Host-Host Protocol for Heterogeneous Computer Networks", Reseau CYCLADES SCH519.1, June 1974.
[Host-Host Protocol, Flow Control, Error Recovery, Protocol]

This paper describes the host-host protocol for the French CYCLADE network. The protocol is significantly different than others in current use and is highly flexible.

Aho, A.V., Denning, P.J., Ullman, J.D., "Principles of Optimal Page Replacement", JACM 18, Jan. 1971.
[Measurement, Performance Evaluation, Paging]

This paper develops a formal statistical model of program behavior in a paging environment. The paper considers various paging algorithms and cost relations.

Alsberg, P.A., "Project Dileptus--A Study of Distributed Computing", Center for Advanced Computation, University of Illinois, Dec. 1973 (draft).
[Distributed Computing, Protocol, Measurement, Process Control, Data Transfer]

The purpose of the Dileptus Project is to study the fundamental relationships involved in distributed systems, to empirically verify these relationships and to develop suitable protocols for distributed computing on the ARPA Network. Of particular interest is the harmonious co-operation of dissimilar machines in a hostile environment. Each component of the system must be suspicious of the correct functioning and good will of its multiple neighbors.

Alsberg, P.A., "Distributed Processing on the ARPA Network--Measurements of the Cost and Performance Tradeoffs for Numerical Tasks", Proc. Eighth Hawaii Internat'l Conference of System Sciences, 1975.
[Measurement, ARPANET, Resource Sharing, Performance Benchmark]

A benchmark of the cost (including network costs) and speed of a typical numerical computation (matrix inversion) for seven different machines on the ARPANET shows that distributed computing pays off earlier than first expected. Rough trends are also given for operations such as file management, console handling, bit flogging, and character manipulation. This paper is one of the first to actually show that distributed computation is cost effective.

Arden, B., Boettner, D., "Measurement and Performance of a Multiprogramming Systems", Proc. Second Symposium on Operating System Principles, Princeton, 1969, pp. 130-146.
[Measurement, Performance Evaluation]

This paper discusses various measures of performance performed on the University of Michigan MTS System. The paper contains some very interesting and helpful graphs and data of the measurements made.

Arora, S.R., Gallo, A., "The Optimal Organization of Multiprogrammed Multi-Level Memory", Proc. ACM Workshop on System Performance Evaluation, 1971, pp. 104-141.
[Measurement, Performance Evaluation, Queueing Theory]

This paper combines a cyclic queueing model and a linear optimization model to investigate cost and throughput issues. The paper derives several interesting results with respect to effects of multiprogramming on response time, cost, and throughput capacity.

Baskett, F., Muntz, R.R., "Queueing Network Models with Different Classes of Customers", IEEE COMPCON72, 1972, pp. 205-209.
[Queueing Network, Network Modeling, Queueing Theory, Network Performance]

Four different types of service centers are handled, and steady state equations are obtained. The model includes considerations for different types of customers with different priorities. An example which resembles a CPU with four I/O devices is studied, and graphs for amount of utilization of each service center (vs. number of customers) are given.

Bauer, M.J., McCredie, J.W., "AMS: A Software Monitor for Performance Evaluation and System Control", Proc. First Annual SIGME Symposium, ACM, 1973, pp. 147-160.
[Measurement, Performance Evaluation, Load Measures]

This paper describes a software monitor system that collects statistics on system load parameters. These measures are then used to dynamically tune the allocation of system resources.

Benoit, J.W., Graf-Webster, E., "REX--A Resource Location and Acquisition Service for the ARPA Computer Network", MITRE Technical Report #387, January 1974, MITRE Corp., McLean, Va.
[ARPANET, Command Language, Distributed Computing, Documentation, Network Accounting, On-line Documentation, Resource Sharing]

Several existing resource sharing systems on the ARPANET are briefly described, and some basic needs of a resource sharing system are discussed. The REX system is described. REX is a system which allows a user to locate a desired resource on the net. This is done using local files. No host-host communication is required.

Bhushan, A., "Data and File Transfer--Some Measurement Results", RFC 573, Sept. 1973.
[File Transfer Protocol, Network Measurement]

This RFC describes results of file transfer measurements on the ARPANET between the MIT-DMS system (a PDP-10) and five other PDP-10's on the network (with either TENEX or ITS operating systems). The measurements are primarily of transfer rate, response time, cost, and availability.

Bressler, R., "Free File Transfer", RFC 487, Apr. 1973.
[Access Control, Accounting, FTP, Security]

This RFC discusses briefly an access control and accounting problem inherent in a network where each host does its own user validation. Also see RFC's 501 and 505.

Bryan, G.E., Shemer, J.E., "The UTS Time-Sharing System: Performance and Evaluation", Proc. Second Symposium on Operating System Principles, Princeton, 1969, pp. 147-158.
[Measurement, Performance Evaluation]

The paper develops a set of statistics that can be used in conjunction with a mathematical model to allow dynamic tuning of the system. The model itself is based on a cyclic queue arranement.

Buchholz, W., "A Synthetic Job for Measuring System Performance", IBM Sys. Journal 8, No. 4, 1969, pp. 309-318.
[Measurement, Performance Evaluation, Synthetic Jobs]

This paper describes the advantages and disadvantages of synthetic benchmarks versus traditional benchmarks. A parameterized synthetic program is developed that effectively exercises both I/O and computational functions.

Buzen, J., "Analysis of System Bottlenecks Using a Queueing Network Model", SIGOPS Workshop on System Performance Evaluation, ACM, April 1971, pp. 82-103.
[System Performance, Queueing Theory, Traffic Analysis]

A model of a single control processor and multiple I/O processors is studied (central server model). All services are assumed exponential and the number of customers is a constant, N, corresponding to the number of partitions in the system. Steady-state probabilities of utilization of each processor are obtained as well as queue lengths. System performance is evaluated and bottlenecks defined.

Cady, G.M., "Computation and Communication Trade-off Studies: An Analytical Model of Computer Networks", Proc. WESCON Conf., 1972, pp. 1-12.
[Measurement, Performance Evaluation, Queueing Theory, Simulation]

The author develops a comprehensive model of a computer network combining the attributes of the hosts and the communications subnet. The article primarily discusses the assumptions and theory on which the model is built.

Campbell D.J., Heffner W., "Measurement and Analysis of Large Operating Systems during System Development", AFIPS FJCC, 1968, pp. 903-914.
[Measurement, Performance Evaluation]

The article describes the kind of measurements that are part of the GCOS III System. The approach taken is basically heuristic. The article discusses the parameters measured and the experience gained, but makes no attempt to draw any general conclusions from the measurements. It appears that the analysis is as heuristic as the choice of measures. The primary value of this paper is that it presents a good view of the rather rich abilities to measure the GCOS system.

Cole, G., "Computer Network Measurements: Techniques and Experiments", UCLA-ENG-7165, UCLA, October 1971.
[Measurement, Traffic Analysis, Modeling]

The development of a measurement capability and the utilization of this capability to create (and iteratively improve) analytic models of network behavior as well as true system parameters is discussed.

Denning, P.J., "A Statistical Model for Console Behavior in Multi-user Computers", CACM 11, 1968, pp. 605-612.
[Measurement, Performance Evaluation, Statistics, Queueing Theory]

This paper develops a highly useful model for console behavior that answers questions relevant to the number of blocked processes, buffer requirements, rate processes can execute, etc.

Denning, P.J., Eisenstein, B.A., "Statistical Methods in Performance Evaluation", Proc. ACM Workshop on System Performance Evalation, 1971, pp. 284-307.
[Measurement, Performance Evaluation, Statistics]

This paper applies the principles of estimation theory to the development of a theory for performance evaluation and resource allocation. The statistical characterization is discussed with reference to bias, convergence, and responsiveness of the parameter.

Estrin, G., Kleinrock L., "Models and Measurements for Time-shared Computer Utilities.", Proc. Conf. ACM, 1967, pp. 85-96.
[Measurement, Performance Evaluation, Queueing Theory]

This paper is a very good survey of the predicted characteristics of queueing theory models of time sharing systems and the results of several measurement projects of such systems. The validity of the models with respect to the measurements is discussed..

Freibergs, I.F., "The Dynamic Behavior of Programs", AFIPS FJCC, 1968, pp. 1163-1167.
[Measurement, Performance Evaluation, Paging]

This paper discusses program behavior (time between supervisor call, page requirements, etc.) for several classes of jobs (Fortran, Cobol, string manipulation, simulation, etc.) from observations of job mixes on an IBM 7044. Several interesting findings indicate that long compute sequences are rare and page requirements between supervisor calls are on the order of two or three pages. This leads the author to conclude that a "one page on demand" strategy should be prohibitively expensive.

Gazis, D.C., "Modeling and Optimal Control of Congested Transportation Systems", Networks 4, 1974, pp. 113-124.
[Queueing Theory, Traffic Analysis, Store and Forward Networks]

An approach is discussed for the modeling of congested transportation systems as store-and-forward networks, analogous to communication networks.

Gelenbe, E., Tiberio, P., Boekhorst, J.C.A., "Page Size in Demand-Paging Systems", Proc. First Annual SIGME Symposium, 1973, pp. 1-12.
[Measurement, Performance Evaluation, Paging]

This paper discusses the problem of page size determination in demand paging systems. The effect of page size on various system performance measures is reviewed in detail. The paper also discusses the wasted space-time integral (WSTI) as a system performance measure, and uses it as a model for program and system behavior.

Gordon, W.J., Newell, G.F., "Closed Queueing Systems with Exponential Servers", Operations Research 15, No. 2, 1967, pp. 254-265.
[Queueing Theory]

This paper deals with constant population closed queueing networks. It is shown that such systems are stochastically equivalent to open systems in which the population may not exceed N. Equilibrium conditions for such a system is solved by a separation of variable technique.

Gordon, W.J., Newell, G.F., "Cyclic Queueing Systems with Restricted Length Queues", Operations Research 15, 1967, pp. 266-277.
[Network Modeling, Network Performance, Queueing Network, Queueing Theory, Congestion]

This paper is concerned with stochastic behavior of a system with capacity restrictions. The closed cyclic system considered is shown to be stochastically equivalent to open sysems in which the number of customers is a random variable. Duality is introduced (as holes moving in the opposite direction). Equilibrium equations for several systems are obtained.

Jackson, J.R., "Networks of Waiting Lines", Operations Research 5, 1957, pp. 518-521.
[Network Modeling, Queueing Theory, Queueing Networks]

'A machine shop' is described as a collection of departments, each with exponential service and exponential arrivals from outside the system. The steady-state distribution of the waiting-line lengths for each department is shown to be independent from that for other departments if mean arrival rate is properly defined.

Jackson, P., Stubbs, C., "A Study of Multiaccess Computer Communications", AFIPS SJCC, 1969, pp. 491-504. [Time Sharing, Analysis, Measurement]

An analytical data stream model, used to describe communications between user and computer, is developed, and a statistical analysis is performed.

Karush, A.D., "Two Approaches for Measuring the Performance of Time-Sharing Systems", Proc. Second Symposium on Operating System Principles, Princeton, 1969, pp. 159-166. [Measurement, Performance Evaluation, Queueing Theory, Benchmark]

This paper considers the "stimulus-black box" and analytic approaches to system measurements. The black box method is seen as cheaper and does not require intimate knowledge of the system. The two techniques are compared for cost, inconvenience, kinds of measurements, and other criteria.

Kernighan, B.W., Hamilton, P.A., "Synthetically Generated Performance Test Loads for Operating Systems", Proc. First Annual SIGME Symposium, 1973, pp. 121-126. [Measurement, Performance Evaluation, Synthetic Jobs]

This paper describes the design and experience with an automated benchmark design facility. The system is divided into two parts: a simple, highly parameterized job, and a generator program that produces a ready-to-run job stream from a specification.

Kimbleton, S.R., Moore, C.G., "A Probabilistic Framework for System Performance Evaluation", Proc. ACM Workshop on System Performance Evaluation, 1971, pp. 337-361. [Measurement, Performance Evaluation, Queueing Theory]

This paper describes a method for comparing throughput, turn-around time, and availability for a processor bound computer system. The authors feel the method is extendable to any system with a "clearly defined limiting resource". The paper also contains some very interesting data on process activity.

Kleinrock, L., "Certain Analytic Results for Time-shared Processors", IFIP Congress 68, pp. 838-845.
[Time Sharing, Terminals, Modeling, Queueing Theory, Traffic Analysis]

A basic model for time-shared systems with M consoles is introduced and analyzed. Published measurements on existing computer systems demonstrate the accuracy of the model in describing the behavior of the normalized average response time, taken as the performance measure of these systems. (author's abstract)

Kleinrock, L., "Analytic and Simulation Methods in Computer Network Design", AFIPS SJCC, 1970, pp. 569-579.
[Queueing Theory, ARPANET, Network Modeling, Network Bandwidth, Network Design, Network Performance, Routing]

Analytical techniques are used to analyze computer networks such as the ARPANET. Methods to synthesize an optimal channel capacity assignment are discussed for three different cost functions, including the real life case of the Telpak rates for leased transmission.

Kleinrock, L., Naylor, W., Opderbeck, H., "A Study of Line Overhead in the ARPANET", General InterNetwork Working Group Note #71, Sept. 1974.
[ARPANET, Packet Communication, Flow Control, Network Measurement, Network Performance, Traffic Analysis, Network Performance Optimization, Protocol, Congestion]

Communication channel overhead on the ARPANET is classified into levels of protocol hierarchy and studied for models of system use. Some measurements of line efficiency on the ARPANET are presented and extrapolations to a heavily loaded network are made. Results are derived for a recently suggested replacement for the HOST-HOST protocol and a comparison is made.

Kobayashi, H., "Application of the Diffusion Approximation to Queueing Networks Part 1--Equilibrium Queue Distributions", Proc. First Annual SIGME Symposium, 1973, pp. 54-63.
[Measurement, Performance Evaluation, Diffusion Approximation, Queueing Networks]

This paper attempts to circumvent the constraints of queueing theory (namely oversimplified models), and apply diffusion process approximation to the modeling of computer systems.

Krinos, J.D., "Interaction Statistics from a Database Management System", AFIPS 42, 1973, pp. 283-290.
[Measurement]

Statistics gathered from monitoring the United Aircraft Information Management System are described. These include response time, cpu usage, and user think time.

McQuillan, J., Crowther, W., Cosell, B., Walden, D., Heart, F., "Improvements in the Design and Performance of the ARPA Network", AFIPS FJCC, 1972, pp. 741-754.
[ARPANET, IMP, Network Design, IMP-IMP Protocol, Flow Control, Store and Forward Networks, Packet Communication, Network Measurement, Network Performance Optimization, Congestion, Deadlock]

New algorithms in the areas of source-to-destination sequence control, source-to-destination flow control, and IMP-to-IMP transmission control are given as a result of the discovery of logical flaws in the interface message processor (IMP) software. Changes in program structure are discussed. Measurements of network throughput, IMP reliability, and IMP performance are given.

Morgan, D.E., Campbell, J.A., "An Answer to a User's Plea?", Proc. First Annual SIGME Symposium, 1973, pp. 112-121.
[Measurement, Performance Evaluation, Benchmark, Synthetic Jobs]

This paper discusses the subject of performance evaluation from the point of view of the user. Problems of how to choose machines, configurations, etc., are discussed. Also, two forms of benchmarks (resource and service demand) and their applicability to various environments are discussed.

Multics, "System Administrator's Manual", Honeywell Info Systems and MIT, Feb. 1973.
[Accounting, User Support, Management Support]

This document describes the capabilities and functions provided the System Administrator of a Multics system. The facilities described include resource control, billing, creating new users, etc.

Muntz, R.R., "Analytic Models for Computer System Performance Analysis", UCLA Computer Science Department Quarterly 2, Jan. 1974, pp. 49-66.
[Network Performance, Network Modeling, Queueing Theory]

Descriptions of several queueing theoretic models are given (Kleinrock's, Buzen's, Moore's, etc.) and restrictions and future developments are described. Some emphasis is put on the author's model which is the only one with different customer classes.

Naylor, W.E., "Real-time Transmission in a Packet Switched Network", Network Measurement Note 15, NIC 19014, Sept 1973.
[ARPANET, IMP, Packet Communication, Measurement, Data Transmission, Packet Communication Analysis]

An experiment was performed on the ARPA network to measure the transmission data rate that one could get for different message sizes. Messages of sizes 1, 40, 62 and 503 words were sent through 1, 3, and 6 "hops" (one hop is transmission from one IMP to a neighboring IMP). Finally, results from a theoretic model are compared with the data.

Nielsen, N., "The Simulation of Time Sharing Systems", CACM 10, July 1967, pp. 397-413.
[Measurement, Performance Evaluation, Simulation]

The paper describes a fairly effective and general time-sharing simulator. The simulator is designed to accommodate a large class of (if not all) timesharing systems, and to allow appraisal of various systems and configurations.

Padlipsky, M.A., "Two Solutions to a File Transfer Access Problem", RFC 505, July 1973.
[Access Control, Accounting, File Transfer Protocol, Security]

This RFC addresses the problems of file access and accounting for file transfers in a network without network-wide accounting. The author offers two solutions which have been used and discusses their implications (See also RFC's 487 and 501.)

Padlipsky, M.A., Calvin, I., Kudlick, M., Greer, C., Crocker, D., "Design Document for a Performance Measurement Laboratory", USING Internal Memo, 1974.
[Performance Evaluation, Measurement, User Support]

The measurement and authentication of services on a network are highly important, not only to determine the best place to get a job done, but also to determine if protocols are implemented correctly and efficiently. This paper discusses a technique for performing that function.

Pewitt, T.C., Su, S.Y.W., "Resource Demanded Paging and Dispatching to Optimize Resource Utilization in an Operating System", Proc. First Annual SIGME Symposium, 1973, pp. 29-36.
[Measurement, Performance Evaluation, Queueing Theory]

This paper uses Buzen's model for evaluation of an operating system. The authors then apply an iterative optimization scheme to determine optimum system parameters.

Pogran, K.T., "Unmuddling Free File Transfer", RFC 501, May, 1973.
[Access Control, Accounting, File Transfer Protocol, Security]

This RFC elaborates on the suggestions made in Bressler's RFC 487. The author examines the problem from another point of view and points up several difficulties in security and accounting. Also see RFC's 487 and 505.

Rozawadowski, R.T., "A Measure for the Quantity of Computation", Proc. First Annual SIGME Symposium, ACM, 1973, pp. 100-111.
[Measurement, Performance Evaluation, Information Theory]

This paper is interesting from two aspects: it nicely parallels Holstead's software physics work, and it provides a very reasonable machine independent measure of computational work. This measure may then be used to compare machine instruction sets, which the paper does.

Saltzer, J.H., Gintell, J.W., "The Instrumentation of Multics", CACM 13, Aug. 1970.
[Measurement, Performance Evaluation]

This paper describes in a cursory manner the measurement facilities provided in Multics. Both hardware and software techniques are presented ranging from a PDP-8 based monitor to evaluation by running a script of user activities.

Sekino, A., "Throughput Analysis of Multiprogrammed Virtual Memory Computer Systems", Proc. First Annual SIGME Symposium, 1973, pp. 47-53.
[Measurement, Performance Evaluation, Paging, Queueing Theory]

This paper combines models of paging behavior of programs under multiprogramming, and of dual processor, multi-memory system with virtual memory to realistically evaluate throughput. The model is compared with actual data from MULTICS, and the effect of multiprogramming is evaluated.

Senko, M.E., "Details of a Scientific Approach to Information Systems", Data Base Systems, R. Rustin, ed., Prentice-Hall, 1972, pp. 143-174.
[Information System Modeling, Information System Measurement, File System Design]

This 1971 Symposium talk is a good, readable introduction to information system modeling in general and Senko's FOREM in particular. (See other papers by Senko et al.)

Spraqins, J.D., "Analysis of Loop Transmission Systems", Second Symposium on Problems in the Optimization of Data Communication Systems, 1971, pp. 175-182.
[Ring Network, Network Analysis, Queueing Theory]

A queueing theory analysis is performed on loop transmission systems with a single controller and random slot assignment with fixed slot size (the 'lazy suzan'). The paper discusses results of the research effort and emphasis the trade-off considerations in the design of loop systems (buffer size, terminal waiting lines, printer impact, etc.).

Waldbaum, G., "Evaluating Computing System Changes by Means of Regression Models", Proc. First Annual SIGME Symposium, 1973, pp. 127-135.
[Measurement, Performance Evaluation, Regression]

This paper discusses how regression models can be applied to system evaluation. The model is applied to the evaluation of changes made to an APL system.

Wilkes, M.V., "Automatic Load Adjustment in Time Sharing Systems", Proc. ACM Workshop on System Performance Evaluation, 1971, pp. 308-320.
[Measurement, Performance Evaluation, Load Measures]

This paper discusses how control theory techniques may be applied to dynamically control system load. Two algorithms are discussed. The first attempts to predict the number of tasks that can be admitted while maintaining control. The second adjusts the number of users such that the load is maintained. The paper considers the stability and oscillatory natures of the algorithms in some detail.

Wulf, W.A., "Performance Monitors for Multi-Programming Systems", Proc. Second Symposium on Operating System Principles, Princeton, 1969, pp. 175-181.
[Measurement, Performance Evaluation]

This paper develops a collection of measures to evaluate total system performance, as well as corresponding per-process measures. The measures are intended for dynamic system tuning and job mix tuning. The measures are fairly rich and show some promise for applicability.

Akkoyunlu, R., Bernstein, A., Schantz, R., "An Operating System for a Network Environment", Department of Computer Science, SUNY at Stony Brook, Tech. Rept. #5.
[Front-end Processor, Ports]

This paper describes a layered operating system based on the inter-process communication techniques of Walden and Balzer to be built on a PDP-15. The system is layered along interesting lines: logical, data port, known item, and user levels.

Aupperle, E., "MERIT Computer Network: Hardware Considerations", Computer Networks, R. Rustin, ed., Prentice Hall, 1972, pp. 49-63.
[MERIT, Centralized System, Distributed System, Communications Processor, Front End Processor, Telecommunications]

The configuration chosen for the MERIT Computer Network is discussed in comparison with alternative choices, and the direction of future techniques of operation is outlined. The principal aspects of the hardware--the communications computer, the telephonic communications, and the interfaces--are described in detail.

Berggreen, A., "Interfacing an Illinois Plasma Terminal to the ARPANET", RFC 600, Nov. 1973.
[Graphics, Intelligent Terminals, Terminals]

This paper describes the hardware involved for interfacing a PLATO terminal to the ARPANET. The difficulties arise from the non-standard nature of the PLATO interface.

Blanc, R., "Availability and Usability of Computer Communication Networks", Seventh Hawaii International Conference on System Sciences - Subconference on Computer Networks, 1974.
[Distributed System, Front-end Processor, Remote Job Entry]

This paper presents a general survey of some considerations in network evaluation and selection.

Bouknight, W.J., Grossman, G.R., Grothe, D.M., "The ARPA Network Terminal System: A New approach to Network Access", Center for Adv. Comp., Univ. of Ill., Urbana, Ill.
[ARPANET, Front-end Processor, Operating Systems]

This paper describes an operating system developed for a PDP-11 as an access medium to the ARPANET. The layered system uses a line-switched oriented interprocess communication method between special processes designed to handle multiple users in a unique way.

Cocanower, A., "MERIT Computer System: Software Considerations", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 65-77.
[Traffic Control, MERIT, Process Synchronization, Inter-process Communication, Communications Processor, Front End Processor, Multi-tasking, Semaphores]

The programming considerations for the MERIT Computer Network are described briefly with respect to host and communication computer philosophy, organization, component description and function, operating system design, and traffic regulation. Implementation difficulties and potential user problems are discussed.

Desautels, E., Chow, V., Schneider, M., "Loosely Coupled Systems", Computer Sciences Technical Report #187, University of Wisconsin at Madison, July 1973.
[Front-end Processor, Time Sharing, Intelligent Terminal]

An outline is given of a current investigation into costs and benefits of coupling a small time sharing system to a large multi-programmed system. Directions of research include the use of the small system as an "intelligent" terminal or a front-end processor.

Herzog, B., "MERIT Computer Network", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 45-48.
[MERIT, Resource Sharing, Front End Processor, Distributed System. Network Design, Network Management]

The objectives and organization of the MERIT Computer Network are discussed from their inception through their projected future development. The historical and administrative compexities are presented. (author's abstract)

Padlipsky, M.A., "A Proposed Protocol for Connecting Host computers to ARPA-like Networks via Front-end Computers", RFC #672, 1974.
[Protocol, ARPANET, Front-end Processor]

This RFC defines a highly flexible protocol for communication between a front-end and a host with significantly less impact on the host than a full NCP in the host. The paper also contains highly relevant "advice" to would-be designers and implementers of network functions.

Sobolewski, J.S., "Programmable Communication Processors", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[Front-end Processor, User Support, Telecommunications]

This paper surveys the field of communication processors for inquiry and response systems, data collection, conversational computing, remote batch, and message switching systems. The role of minicomputer configurations is explored in each of these areas. The advantages and disadvantages of communication processors is discussed (the primary disadvantage being the lack of manufacturer supported software). This is a decent introductory paper.

Ackerman, W., Plummer, W., "An Implementation of a Multiprocessing Computer System", Proceedings ACM Symposium on Operating System Principles, 1967.
[Protection, Resource Allocation, Process Synchronization, Timesharing]

A multi-processing system implemented on a PDP-1 is discussed. Principal design criteria were: supervisor modularity through independent and synchronous processes; user mode process control of I/O functions; and an effective scheme for allocation and protection of system resources. Protection is implemented by a capability list (C-list) associated with each computation. Multi-processing primitives (meta-instructions), are discussed in detail in relation to interrupt handling, protection, I/O, and process control.

Alsberg, P., Day, J., Purdy, G., "Automated Resource Sharing on the ARPA Network", Center for Advanced Computation Report, Univ. of Ill., May 1973.
[Automated Resource Sharing, ARPANET, Distributed Computing, Security, Name Space Management, File Access Protocols, Process Control Protocols]

The design of a network-based distributed computing system to take advantage of some unique, heterogeneous resources available to the Center for Advanced Computation over the ARPANET is discussed. Four problems currently impeding the use of the ARPANET as a resource sharing utility--network security, name space management, file access protocols, and process control protocols, are discussed. In addition, a security coding system to control resource sharing is described.

Baskin, H., Borgerson, B., Roberts, R., "PRIME--A Modular Architecture for Terminal Oriented Systems", AFIPS SJCC 40, 1972, pp. 431-437.
[Operating System, Multi-processing, Security, Error Detection, Error Recovery, Time Sharing, Computer Hardware, Reliability]

In this system a basic assumption is that failures exist as a normal occurence, rather than a special state, and they must be treated while continuing as near normal operation as possible. PRIME is a modular, canonical system consisting of n identical subsystems which can process n independent jobs with a high degree of protection from each other.

Baskin, H., Horowitz, E., Tennison, R., Rittenhouse, L., "A Modular Computer Sharing System", CACM 12, Oct. 1969, pp. 551-559.
[Operating System, Multi-processing, Security, Error Detection, Error Recovery, Time-sharing, Computer Hardware]

The system organization used is a bank of interchangeable computers, each consisting of a memory/processor pair, which are assigned to process terminal jobs as they arrive. One computer serves as master and supervises collection and distribution of messages from and to remote terminals. In simplest form, each computer has associated with it a disk drive assigned under control of the master computer.

Baum, R.I., Hsiao, D.K., "A Semantic Model for Protection Mechanisms in the Data Base System", Eighth Hawaii Int'l. Conf. on System Sciences, 1975, pp. 175-179.
[Access Control, Data Security]

Given a data base, the relationships which exist between items in the data base, and the fact that a certain user is not to gain knowledge of certain items, this paper presents a variety of protection methods which vary in complexity of implementation and the total amount of information withheld.

Bensoussan, A., Clingen, C., Daley, R., "The MULTICS Virtual Memory", ACM Second Symposium on Operating Systems Principles, October 1969, pp. 30-42.
[MULTICS, Virtual Memory, Access Control, Data Sharing, Segmentation, Paging, Address Space]

Design and implementation considerations of segmentation and paging in MULTICS are discussed in detail. It is shown how the MULTICS supervisor, in conjunction with the GE 645 segmentation and paging hardware, utilizes the virtual memory.

Bressler, R., "Free File Transfer", RFC 487, Apr. 1973.
[Access Control, Accounting, FTP, Security]

This RFC discusses briefly an access control and accounting problem inherent in a network where each host does its own user validation. Also see RFC's 501 and 505.

Browne, P., Steinauer, D., "A Model for Access Control", ACM SIGFIDET Workshop on Data Description, Access and Control, 1971, pp. 241-262.
[Access Control, Resource Sharing, Authorization, Protection]

The problems of authorization for a multiple-user resource sharing data processing system are discussed. The requirements for the access of objects (e.g., terminals, users, programs, etc.) to other objects are covered in some detail. A model for access control is developed which combines the military-type level (tree-structured) classification and a category or clique classification. No discussion is given of efficiency, issues of identification, or other advantages and disadvantages of the model.

Chu, W.W., Ohlmacher, G., "Avoiding Deadlock in Distributed Data Bases", Proc. ACM, 1974, pp. 156-160.
[Access Control, Data Base Integrity, Deadlock Prevention, Distributed System]

This paper discusses three methods of deadlock prevention or detection based on availability of prior knowledge of file use by a process, and whether files are pre- or demand-allocated. Ways of implementing all three techniques on a distributed network are presented.

Daley, R., Dennis, J., "Virtual Memory, Processes, and Sharing in MULTICS", CACM 11, May 1968, pp. 306-312.
[MULTICS, Virtual Memory, Data Sharing, Dynamic Linking, Multi-programming, Storage Management, Storage Hierarchies, Resource Sharing, Security]

Basic concepts involved in the design of the MULTICS operating system, such as processes, address space, and virtual memory, are introduced and defined. Procedure and data sharing is discussed and the dynamic transformation of symbolic references into virtual machine addresses is described in detail.

Dean, A.,Jr., "Data Privacy and Integrity Requirements for On-line Data Management Systems", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 279-298.
[Data Security, Data Integrity]

This paper identifies the data privacy and integrity capabilities required by an online data management system. The overall operation of an online data management system, the hardware, operating software, and application software of an online data management system are described in terms of the data privacy and integrity capabilities to be supplied by each of these parts of a system.

Fabry, R.S., "Dynamic Verification of Operating System Decisions", CACM 16, Nov. 1973, p. 659.
[Operating System, Data Security, Error Detection, Protection]

A description of Berkeley's PRIME system is given. Protection against "leakage" of data due to operating system failure is provided by software-firmware redundancy. Key decisions (e.g., process creation, page allocate/deallocate, messages) made by software must go through, and be verified by, the firmware.

Friedman, T.D., "The Authorization Problem in Shared Files", IBM Systems Journal 9, No. 4, 1970.
[Authorization, Data Accessing, Data Security, Privacy, Security]

The author develops a scheme for controlling access to data at the per-field level which can withstand almost all attempts at circumvention, with small effects to response time.

Graham, G.S., Denning, P.J., "Protection--Principles and Practice", AFIPS SJCC, 1972, pp. 417-429.
[Security, Protection, Access Control, Domain]

This paper builds upon Lampson's domains (FJCC 1969). An expanded domain scheme using a larger number of types of access is explained in detail, and proven correct. Implementation of the scheme is discussed, including comparisons with several existing operating systems (OS/360, RC 4000, Multics).

Graham, R., "Protection in an Information Processing Utility", CACM 11, May 1968, pp. 365-369.
[Protection, Privacy, Security, Access Control, Data Sharing]

Information processing utility properties which make protection necessary are discussed and the essential properties for a protection scheme are defined. An abstract model of the hardware features and companion software necessary to implement this model are described.

Hassing, T., Hampton, R., Bailey, G., Gardella, R., "A Loop Network for General Purpose Communication in a Heterogeneous World", Data Networks: Analysis and Design, DATACOM73, 1973, pp. 88-96.
[Network Topology, Protocol, Security, Data Sharing]

A packet switching data communictions network under development at the National Security Agency for resource sharing and future development of distributed processing and filing systems is described. The network will consist of a hierarchy of interconnected loops or rings, probably based on Bell System T carrier digital transmission technology. Also discussed are the means of nodal connection to the loops, nodal configuration, network protocols, design and security considerations, and implications for the future.

Hoffman, L.J., "The Formulary Model for Flexible Privacy and Access Controls", AFIPS 39, 1971, pp. 587-601.
[Access Control, Data Accessing, Privacy]

This paper discusses a method for using a set of procedures to dynamically control access to the information in a data base. This is done in such a way that access can be determined on a per item (rather than per file) basis.

Jones, P.D., "Operating System Structures", IFIP Congress, 1968, pp. 525-530.
[Timesharing, Protection Hierarchy, Centralized Operating System]

Three existing operating systems are reviewed in terms of advantages and disadvantages. A very general description of some basic operating system concepts is given.

Lampson, B.W., "Protection", Proc. Fifth Princeton Symposium on Information Sciences and Systems, March 1971, pp. 437-443.
[Access Control, Security]

Abstract models are given which reflect the properties of most existing mechanisms for enforcing protection or access control, together with some possible implementations. The properties of existing systems are explicated in terms of the model and implementations. (author's abstract)

Lampson, B.W., "A Note on the Confinement Problem", CACM 16, Oct 1973, pp. 613-615.
[Protection, Security, Privacy]

Some of the ways that a user's data could be "leaked" by a service program are discussed, and some comments are made on what confinement rules should be followed by an operating system to guard against this happening.

Lampson, B.W., "Dynamic Protection Structures", AFIPS FJCC, 1969, pp. 27-38.
[Security, Protection, Access Control, Domain]

This paper describes domains, or the set of capabilities (access rights) of a process. Most aspects of protection are discussed in this context, including passing permissions between domains, transfer of control between domains, and proprietary programs (mutually suspicious subsystems).

Morris, J.H., "Protection in Programming Languages", CACM 16, Jan. 1973, pp. 15-21.
[Access Control, Protection]

This paper discusses protection of subprograms from malfunctions of other subprograms. Methods of enforcing user-created type restrictions thru software and restriction of variables to specific programs are discussed.

Needham, R., "Protection-A Current Research Area in Operating Systems", International Computing Symposium, 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1974, pp. 123-126.
[Protection, Security, Access Control, Process Synchronization]

An approach to protection, involving the notion of "regimes of protection" which denote the data a process can access, the variety of access permitted, that selection of other processes it may call, and transitions available to other regimes of protection, is presented. Advantages and disadvantages inherent in the scheme and its implementation are discussed.

Owens, R., "Evaluation of Access Authorization Characteristics of Derived Data Sets", ACM SIGFIDET Workshop on Data Description, Access, and Control, 1971, pp. 263-278.
[Data Security]

The capabilities necessary for preserving privacy in the context of a large scale data management system designed to support nontrivial decision making is described. This paper details a technique for providing those capabilities in a relational data management system and demonstrates the feasibility of a system which goes part way toward providing an environment in which privacy can be protected; moreover, it is shown that providing this environment will not be an easy task.

Padlipsky, M.A., "Two Solutions to a File Transfer Access Problem", RFC 505, July 1973.
[Access Control, Accounting, File Transfer Protocol, Security]

This RFC addresses the problems of file access and accounting for file transfers in a network without network-wide accounting. The author offers two solutions which have been used and discusses their implications (See also RFC's 487 and 501.)

Padlipsky, M.A., "What is 'Free'?", RFC 491, Apr. 1973.
[File Transfer Protocol, Access Control, Security]

This RFC discusses the problems of free system access to provide services such as mail. The problem of the necessity of login is discussed, and several solutions are entertained.

Patterson, A.C., "Requirements for a Generalized Data Base Management System", AFIPS FJCC 39, 1971, pp. 515-522.
[Data Management Overview, Security, Data Accessing]

This paper briefly discusses the GUIDE/SHARE report on generalized requirements of data management systems. It contains more than two pages of glossary of data management-type terms, which may be of some use to the novice.

Pogran, K.T., "Unmuddling Free File Transfer", RFC 501, May, 1973.

[Access Control, Accounting, File Transfer Protocol, Security]

This RFC elaborates on the suggestions made in Bressler's RFC 487. The author examines the problem from another point of view and points up several difficulties in security and accounting. Also see RFC's 487 and 505.

Popek, G.J., "Protection Structures", Computer, June 1974, pp. 22-33.
[Access Control, Data Security, Privacy, Protection, Security]

This paper starts with a general discussion of privacy and security. It then surveys control disciplines and protection models in some detail, with numerous references to the literature (84 references).

Popek, G.J., Kline, C.S., "Verifiable Protection Systems", To be presented at the ACM/IEEE Software Reliability Conference in LA, CA., Apr. 1975.
[File System Design, Kernel, Access Control, Data Security, Privacy, Protection, Security, Co-operating Processes, Multi-programming]

This paper primarily describes the UCLA/VM project at UCLA. UCLA/VM is a PDP 11/45-based virtual machine kernel that is verifiable, secure, and a virtualizing package that creates virtual PDP 11/45's.

Popek, G.J., Kline, C.S., "Verifiable Secure Operating System Software", AFIPS NCC, 1974, pp. 145-151.
[Access Control, Data Security, Privacy, Protection, Kernel, Security, Co-operating Processes, Multi-programming]

This paper discusses some aspects of secure operating systems, describes the concepts of security kernels and virtual machines, mentions several difficult security problems, and briefly mentions some aspects of verification of security kernels. The UCLA-VM system, a prototype security kernel and support software for the PDP 11/45, is mentioned briefly. Brief arguments concerning the cost of security are presented.

Quatse, J., Gaulene, P., Dodge, D., "The External Access Network of a Modular Computer System", AFIPS SJCC 40, 1972, pp. 783-789.
[Resource Sharing, Security, Message Processing, PRIME, Protection, Error Detection, Inter-process Communication]

The PRIME system consists of sets of modules dynamically reconfigured into separate subsystems. Three classes of communications are needed: processor-to-processor, processor-to-facility pool device-(e.g. disk drive), primary memory-to-facility pool device. This paper descrioes the structure and components of the External Access Network (EAN) developed for this purpose.

Saltzer, J.H., "Protection and the Control of Information Sharing in Multics", CACM 17, July 1974, pp. 338-402.
[MULTICS, Security, Privacy, Access Control, Data Sharing, Time Sharing, Virtual Memory, Storage Hierarchies]

Design principles and goals of Multics, a highly secure time-sharing system, are described. The schemes Multics uses to implement the design goals are described in detail, and a discussion of the tradeoffs and weaknesses of the implementation is included. The design principles and access control, authentication, and protection mechanisms discussed in this paper are important concepts in the field of secure operating systems.

Schroeder, M., Saltzer, J., "A Hardware Architecture for Implementing Protection Rings", CACM 15, March 1972, pp. 157-170.
[Protection, Security, Access Control, MULTICS, Virtual Memory]

Criteria are presented for the design of access control mechanisms, and the processor mechanisms for implementing protection rings are described. Finally, advantages and possible uses for protection rings are discussed.

Schroeder, M.D., "Cooperation of Mutually Suspicious Subsystems in a Computer Utility", Report #MAC TR-104, Project MAC, MIT.
[Security, Access Control, MULTICS]

A protection scheme based on capabilities and protection domains is described. The scheme is efficiently implementable in hardware and extends the methods developed for and implemented by the Honeywell 6180 MULTICS processor. Impacts of the design on the supporting operating system are discussed.

Spier, M., Hastings, T., Cutler, D., "An Experimental Implementation of the Kernel/Domain Architecture", Operating Systems Review 7, Oct. 1973, ACM, pp. 8-21.
[Domain, Domain Incarnation, Kernel, Protection]

The conceptual background and framework of a software simulated kernel/domain architecture is described. The need for storage class semantics, which do not exist in current high level languages, is explored. Functional implications, such as the design of a simple CPU scheduler, are given.

Summerill, L.F., Kory, M., "Security in Data Management", Eighth Hawaii Int'l Conf. on System Sciences, 1975, pp. 191-194.
[Access Control, Data Security, Security]

This paper briefly discusses many of the various aspects that go into a secure system, ranging from building security guards to aspects of monitoring process activities. Contains some good, short definitions of key phrases.

Summers, R.C., Fernandez, E.B., Coleman, C.D., "Shared Data Access Control with Programming Language Support", Eighth Hawaii Int'l. Conf. on System Sciences, 1975, pp. 187-190. [Access Control]

This paper describes a method of classifying users, application programs, data items, restrictions based on specific data items, etc., into groups, in a way such that access control can be implemented with only a few changes to a currently existing higher level programing language.

Thomas, R., "On the Problem of Signature Authentication for Network Mail", RFC 644, July 1974.
[Mail, Access Cotrol, Security, Authentication]

This paper discusses one approach to the authentication of mail senders, i.e., is the mail from who it says it is. The approach relies on the assumption that local authentication is possible and then attempts to build the necessary capabilities on this.

Weis, A., "Distributed Network Activity at IBM", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 1-25.
[RJE, Resource Sharing, TSS, Protocol, Centralized System, Distributed System, Security]

IBM experimental network activities, related to TSS, during 1968- 1972 are described. Some of the outstanding problems that will have to be addressed during the coming years in the area of computer networks are discussed.

Wulf, W., Cohen, E., Corwin, W., Jones, A., Levin, R., Pierson, C., Pollack, F., "HYDRA: The Kernel of a Multiprocessor Operating System", CACM 17, June 1974, pp. 337-345.
[Operating System, Security, Resource Allocation, Centralized System]

This paper describes the operating system for the Carnegie-Mellon Multi-Mini-Processor. HYDRA is designed to facilitate experimentation, and design goals toward that end are described. The notions of resources, objects, and capabilities are described in detail, and an extended example is given.

Network Application Support Subtopics

13. User Support
14. Management Support
15. Network Support

Benoit, J.W., Graf-Webster, E., "REX--A Resource Location and Acquisition Service for the ARPA Computer Network", MITRE Technical Report #387, January 1974, MITRE Corp., McLean, Va.
[ARPANET, Command Language, Distributed Computing, Documentation, Network Accounting, On-line Documentation, Resource Sharing]

Several existing resource sharing systems on the ARPANET are briefly described, and some basic needs of a resource sharing system are discussed. The REX system is described. REX is a system which allows a user to locate a desired resource on the net. This is done using local files. No host-host communication is required.

Bhushan, A.K., "FTP and Network Mail System", RFC #475, Mar 1973.
[Mail, FTP, User Support]

This paper contains another view of a Network Mail Meeting held in March, 1973 (see RFC 469). This paper considers the points made at the meeting and their implications to the File Transfer Protocol. Bhushan discusses access control, mail to TIP's, mail use scenarios, and other topics discussed at the meeting. This paper makes a good companion to Kudlick's discussion of the same meeting.

Bressler, R., Thomas, R., "Inter-Entity Communication--An Experiment", RFC 441, Jan. 1973.
[Resource Sharing, User Support]

This paper describes highly successful early attempts on the ARPANET to develop techniques of user-user communication. The experiment allowed a user to "find" another user if he was on any other machine on the network participating in the experiment. He was also able to talk to the user, show the user what he was doing, etc. The experiment was performed between the PDP-10 at MIT-DMCG and the various PDP-10 TENEX systems.

Burroughs Corp., "Work Flow Language User's Manual", Burroughs Corp., 1973.
[Command Language, User Support]

This document describes the implementation of a job control language. WFL designers have done many things correctly in providing a clear, easy to use ALGOL-like language that should be inspected by any designer of a job stream language.

Calvin, J.O., "The Design and Implementation of an Interactive Teleconferencing Environment", Undergraduate Thesis, Case Western Reserve Univ., May 1974.
[Teleconferencing, ARPANET]

This paper describes the design and implementation of a network teleconferencing protocol and server for the ARPANET. The protocol and its implementation (for the PDP-10 Tenex) constitutes one of the most sophisticated teleconferencing systems developed to date.

Constant, M.L., Seeley, P.L., "Computer-Mediated Human Communications in an Air Traffic Control Environment: A Preliminary Design", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[Teleconferencing]

The air traffic controller is required to be not only a manager and decision maker but also a data processor, manipulator, and recorder in addition to a data transmission device. This paper discusses the use of the computer to relieve the load on the controller.

Crocker, D., Day, J., Hill, A., Kudlick, M., "Considerations in Defining and Evaluating a Network Service", USING Note available through NIC, Jan. 1974.
[User Support]

This paper was prepared for USING as a guideline for servers and the quality of service. Points addressed are system stability, availability, reliability, documentation, file system maintenance, etc.

Crocker, D., Neiger, N., Feinler, J., Iseli, J., "ARPANET Users Interest Group Meeting", RFC 585, Nov. 1973.
[User Support]

This RFC reports the first meeting of USING and the problems it set about to address. These problems, e.g., documentation and consulting, user standard interfaces, user feedback mechanisms, accounting, etc., are highly relevant to any heterogeneous network.

Crocker, D., Postel, J., "Thoughts on the Mail Protocol Proposed in RFC 524", RFC 539, July 1973.
[Mail, User Support]

This RFC is one of the critiques of White's Mail Protocol. The paper makes several points, some of a minor nature, on the protocol produced by White, and suggests improvements.

Honeywell Info Systems and MIT, "Multics Project Administrator's Manual", Honeywell Info Systems and MIT, Feb. 1973.
[User Support, Management Support]

This document describes the support for a Project Administrator on a Multics system. The facilities include assigning resource limits to project members, load control, preemption, etc.

Irby, C.A., "Display Techniques for Interactive Text Manipulation", AFIPS NCC 43, 1974, pp. 247-255.
[Display, Documentation, Graphics, Interactive, User Support]

Irby presents a detailed conceptual model for textual displays in an interactive environment. He lists seven requirements for the model, based on the concept that separate portions of the display (called "windows") may be handled in different fashions or by different programs. The model has been implemented on a TENEX as NLS.

Iseli, J., Poh, S., Sternick, H.J., "Description of a Proposed ARPANET HELP Facility", MITRE Technical Report MTR-6723, MITRE Corporation, McLean, Va.
[User Support, Documentation]

The need for on-line tutorial and other information in a heterogeneous computer network provides the impetus for a network-wide HELP facility. This paper discusses the pros and cons of several alternative implementations for such a facility. The alternative chosen is then discussed in greater detail showing what facilities would be necessary and how they could be provided.

Kudlick, M.D., "Network Mail Meeting Summary", RFC 469, March 1973.
[Mail, FTP, User Support]

This paper records a Network Working Group meeting held in March, 1973, which led to White's Mail Protocol. This paper provides good insights into the problems considered and possible solutions for a network mail facility and problems that were left open at this time. Many important points were considered, such as the roles of TIP's, the role of the Network Information Center, maintenance of addresses, etc.

Lipinski, A., Lipinski H., Randolf, R., "Computer-Assisted Expert Interrogation: A Report on Current Methods development", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[Teleconferencing]

This paper discusses the present efforts of the Institute for the Future to use a teleconferencing system as a means for eliciting the judgements of experts for solutions of interdisciplinary problems. The paper discusses the problems of evaluating experts and integrating their opinions.

Mader, E., "Network Debugging Protocol", RFC 643, July 1974.
[Protocol, Debugging, User Support]

This document describes a protocol to implement a cross-net debugger for PDP-11's. The protocol bypasses the standard Host-Host protocol and assumes the remote machine is capable of performing low level debugging tasks.

Multics, "System Administrator's Manual", Honeywell Info Systems and MIT, Feb. 1973.
[Accounting, User Support, Management Support]

This document describes the capabilities and functions provided the System Administrator of a Multics system. The facilities described include resource control, billing, creating new users, etc.

Neiger, N., "Comments on CCL", NIC 30071, 1974.
[User Support, Command Language, Network Command Language]

This paper discusses the proposal of the UULP on the ARPANET (see Tentative Proposal for a Unified User Level Protocol). This author sees the main problems as a contention between standardization and resource sharing, and suggests Thomas' view (see Comments on the Common Command Language Effort) as the best solution rather than resolving the contention as Padlipsky proposed.

Padlipsky, M.A., "Tentative Proposal for a Unified User Level Protocol", RFC 451, Feb. 1974.
[User Support, UULP, Command Language]

This is the first of a series of papers on a more unified approach to network services on the ARPANET. The proposal discusses the proliferation of contact sockets for new service protocols, and the duplication of effort sometimes necessary because of the approach.

Padlipsky, M.A., "Comments on CCL.DOC", USING CCL committee paper, 1974.
[Network Command Language, User Support, Command Language]

This paper contains Padlipsky's response to Thomas' comments (see Comments on the Common Command Language Effort). This paper addresses each point of Thomas' paper. This whole series makes good reading for the designer of a network command language.

Padlipsky, M.A., "Beyond the Telephone Line Surrogate: Specification of the Unified User Level Protocol", USING Note, 1974.
[User Support]

This paper is the predecessor of RFC 666. It is listed here mainly for completeness and the discussion it provoked.

Padlipsky, M.A., "NETED: A Common Editor for the ARPA Network", RFC 569, Oct. 1973.
[Resource Sharing, User Support, Editor]

This document provides a functional description of a common network editor. The editor is based on the Multics editor, EDS. This choice was made because of its simplicity and ease of definition.

Padlipsky, M.A., Calvin, I., Kudlick, M., Greer, C., Crocker, D., "Design Document for a Performance Measurement Laboratory", USING Internal Memo, 1974.
[Performance Evaluation, Measurement, User Support]

The measurement and authentication of services on a network are highly important, not only to determine the best place to get a job done, but also to determine if protocols are implemented correctly and efficiently. This paper discusses a technique for performing that function.

Schuyler, J., "ORACLE: Computerized Conferencing in a Computer-Assisted-Instruction System", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[Teleconferencing]

This paper describes a teleconferencing system developed for the social sciences to augment the effectiveness of the questionaire by utilizing a modified Delphi technique.

Sobolewski, J.S., "Programmable Communication Processors", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[Front-end Processor, User Support, Telecommunications]

This paper surveys the field of communication processors for inquiry and response systems, data collection, conversational computing, remote batch, and message switching systems. The role of minicomputer configurations is explored in each of these areas. The advantages and disadvantages of communication processors is discussed (the primary disadvantage being the lack of manufacturer supported software). This is a decent introductory paper.

Thomas, R., "A Resource Sharing Executive for the ARPANET", BBN Report 2522, March 1973.
[Resource Sharing, User Support]

This describes the RSEXEC system developed for ARPANET TENEX's. The program allows inter-entity functions as described in Bressler's paper (see RFC 441), an environment for file transfer and mail, and maintenance of a list of accessed files.

Thomas, R., "Comments on the Common Command Language Effort", Personal paper to CCL Committee, 1974.
[User Support, Command Language, Network Command Language]

This paper discusses perceived problems with the proposals made in a predecessor of RFC 666. The paper considers the proposal from a different point of view shedding some light on questions such as machine readable versus human readable protocols, resource sharing, etc., and ends with a counter proposal.

Thomas, R., "On the Problem of Signature Authentication for Network Mail", RFC 644, July 1974.
[Mail, Access Cotrol, Security, Authentication]

This paper discusses one approach to the authentication of mail senders, i.e., is the mail from who it says it is. The approach relies on the assumption that local authentication is possible and then attempts to build the necessary capabilities on this.

Turoff, M., "PARTY-LINE and DISCUSSION Computerized Conference Systems", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[Teleconferencing]

This paper discusses two systems developed by the Office of Emergency Prepardedness as adjuncts to their EMISARI information management system. An analysis of the cost and effectiveness of teleconferncing versus the face to face meeting is presented in good detail.

White, J.E., "Response to Critiques of the Proposed Mail Protocol", RFC #555, July 1973.
[Mail, User Support]

This RFC provides a good look at the protocol designer's response to criticism of his design and how the protocol is changed to meet the criticism. More specifically, this RFC provides more discussion of the requirements of both use and implementation of the protocol.

White, J.E., "A Proposed Mail Protocol", RFC 524, June 1973.
[Mail, User Support]

This paper gives a detailed specification of a Mail Protocol for the ARPANET. The protocol provides many sophisticated functions such as forwarding, distribution control, clerking, etc. This paper is a must for any attempts at good on-line mail service.

Alsberg, P., Day, J., Purdy, G., "Automated Resource Sharing on the ARPA Network", Center for Advanced Computation Report, Univ. of Ill., May 1973.
[Automated Resource Sharing, ARPANET, Distributed Computing, Security, Name Space Management, File Access Protocols, Process Control Protocols]

The design of a network-based distributed computing system to take advantage of some unique, heterogeneous resources available to the Center for Advanced Computation over the ARPANET is discussed. Four problems currently impeding the use of the ARPANET as a resource sharing utility--network security, name space management, file access protocols, and process control protocols, are discussed. In addition, a security coding system to control resource sharing is described.

Alsberg, P.A., "Distributed Processing on the ARPA Network--Measurements of the Cost and Performance Tradeoffs for Numerical Tasks", Proc. Eighth Hawaii Internat'l Conference of System Sciences, 1975.
[Measurement, ARPANET, Resource Sharing, Performance Benchmark]

A benchmark of the cost (including network costs) and speed of a typical numerical computation (matrix inversion) for seven different machines on the ARPANET shows that distributed computing pays off earlier than first expected. Rough trends are also given for operations such as file management, console handling, bit flogging, and character manipulation. This paper is one of the first to actually show that distributed computation is cost effective.

Benoit, J.W., Graf-Webster, E., "REX--A Resource Location and Acquisition Service for the ARPA Computer Network", MITRE Technical Report #387, January 1974, MITRE Corp., McLean, Va.
[ARPANET, Command Language, Distributed Computing, Documentation, Network Accounting, On-line Documentation, Resource Sharing]

Several existing resource sharing systems on the ARPANET are briefly described, and some basic needs of a resource sharing system are discussed. The REX system is described. REX is a system which allows a user to locate a desired resource on the net. This is done using local files. No host-host communication is required.

Bensoussan, A., Clingen, C., Daley, R., "The MULTICS Virtual Memory", ACM Second Symposium on Operating Systems Principles, October 1969, pp. 30-42.
[MULTICS, Virtual Memory, Access Control, Data Sharing, Segmentation, Paging, Address Space]

Design and implementation considerations of segmentation and paging in MULTICS are discussed in detail. It is shown how the MULTICS supervisor, in conjunction with the GE 645 segmentation and paging hardware, utilizes the virtual memory.

Betourne, C., Boulenger, J., Ferrie, J., Kaiser, C., Kott, J., Krakowiak, S., Mossiere, J., "Process Management and Resource Sharing in the Multiaccess System 'ESOPE'", ACM Second Symposium on Operating Systems Principles, October 1969, pp. 67-74.
[Resource Sharing, Process Control, Process Synchronization, File System Design, Virtual Memory, Resource Allocation]

Process management, virtual memory, file system organization, memory allocation, and user scheduling are discussed generally in relation to the main design principles of the multiaccess system ESOPE. No actual implementation details are given.

Bhushan, A., Ryan, N., "Using MIT-MATHLAB MACSYMA from MIT-DMS MUDDLE--An Experiment in Automated Resource Sharing", NIC #19501.
[Automated Resource Sharing]

This paper describes an experiment in nontrivial automated resource sharing between the MUDDLE system at MIT-DMS and the MACSYMA system at MIT-MATHLAB in such a manner that the MUDDLE-user is not required to know anything about the ARPA Network, MATHLAB, or even MACSYMA.

Bressler, R., "Interprocess Communication on the ARPA Computer Network", MIT Civil Engineering MS Thesis, June 1971.
[Inter-process Communication, Co-operating Processes, Resource Sharing, Time Sharing, IMP, NCP, Socket, Flow Control, ARPANET]

The development of a Network Control Program (NCP) for the ITS PDP-10 timesharing system is outlined. The relationship between the I/O structure of a time sharing system and the network as an I/O device is defined. Finally, the control commands and the choice of sockets as the mapping device for the link space is examined and suggestions for improvement in the NCP are given.

Bressler, R., "Free File Transfer", RFC 487, Apr. 1973.
[Access Control, Accounting, FTP, Security]

This RFC discusses briefly an access control and accounting problem inherent in a network where each host does its own user validation. Also see RFC's 501 and 505.

Bressler, R., Thomas, R., "Inter-Entity Communication--An Experiment", RFC 441, Jan. 1973.
[Resource Sharing, User Support]

This paper describes highly successful early attempts on the ARPANET to develop techniques of user-user communication. The experiment allowed a user to "find" another user if he was on any other machine on the network participating in the experiment. He was also able to talk to the user, show the user what he was doing, etc. The experiment was performed between the PDP-10 at MIT-DMCG and the various PDP-10 TENEX systems.

Browne, P., Steinauer, D., "A Model for Access Control", ACM SIGFIDET Workshop on Data Description, Access and Control, 1971, pp. 241-262.
[Access Control, Resource Sharing, Authorization, Protection]

The problems of authorization for a multiple-user resource sharing data processing system are discussed. The requirements for the access of objects (e.g., terminals, users, programs, etc.) to other objects are covered in some detail. A model for access control is developed which combines the military-type level (tree-structured) classification and a category or clique classification. No discussion is given of efficiency, issues of identification, or other advantages and disadvantages of the model.

Daley, R., Dennis, J., "Virtual Memory, Processes, and Sharing in MULTICS", CACM 11, May 1968, pp. 306-312.
[MULTICS, Virtual Memory, Data Sharing, Dynamic Linking, Multi-programming, Storage Management, Storage Hierarchies, Resource Sharing, Security]

Basic concepts involved in the design of the MULTICS operating system, such as processes, address space, and virtual memory, are introduced and defined. Procedure and data sharing is discussed and the dynamic transformation of symbolic references into virtual machine addresses is described in detail.

Dijkstra, E.W., "A Class of Allocation Strategies Inducing Bounded Delays Only", AFIPS SJCC, 1972.
[Resource Sharing, Multi-programming, Process Synchronization]

A set of conditions and an allocation strategy are presented that prevent starvation in any of a set of processes competing for a set of resources.

Dijkstra, E.W., "Co-operating Sequential Processes", Programming Languages, F. Genuys, ed., Academic Press, New York 1968.
[Resource Sharing, Multi-programming, Process Synchronization, Interprocess Communication, Semaphore]

This paper describes the general problems encountered by co-operating sequential processes and some specific solutions. A set of primitives to effect co-ordination between co-operating sequential processes is motivated and developed. These primitives, the P and V operations on an object called a semaphore, are discussed in detail with examples. Co-operation using status variables, with semaphores providing mutual exclusion, to permit more arbitrary co-ordination than semaphores allow is also described. Finally, the banker's algorithm, a deadlock prevention scheme, is motivated and described.

Frank, H., Kleinrock, L., Kahn, R.E., "Computer Communication Network Design--Experience with Theory and Practice", AFIPS SJCC 40, 1972, pp. 255-270.
[Distributed System Technology, Message Switching, Network Design, Store and Forward Communications, Resource Sharing, ARPANET, Network Topology, Modeling, Flow Control, Routing, Error Detection, Error Recovery]

Major problems relating to IMP design, topological design, and network modeling on the ARPA network are discussed and the major design techniques which have evolved to deal with them are given.

Harslem, E., Heafner, J., "Aspects of Large-Scale Resource Sharing through Networks of Computers", Rand P-4833, May 1972.
[ARPANET, Distributed Computing, Resource Sharing]

This paper discusses the desirability of distributed computer networks, and contains a description of ARPANET properties and development. A prognosis is given for network developments in the near future.

Herzog, B., "MERIT Computer Network", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 45-48.
[MERIT, Resource Sharing, Front End Processor, Distributed System, Network Design, Network Management]

The objectives and organization of the MERIT Computer Network are discussed from their inception through their projected future development. The historical and administrative compexities are presented. (author's abstract)

Honeywell Info Systems and MIT, "Multics Project Administrator's Manual", Honeywell Info Systems and MIT, Feb. 1973.
[User Support, Management Support]

This document describes the support for a Project Administrator on a Multics system. The facilities include assigning resource limits to project members, load control, preemption, etc.

Kahn, R., "Terminal Access to the ARPA Computer Network", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 147-166.
[ARPANET, Store and Forward Communications, IMP, Resource Sharing, Time Sharing]

The goals and current developments in the ARPA Network are discussed. The characteristics of a Terminal IMP are described. The Terminal IMP (TIP) will permit direct connection to the ARPA Network.

Kleinrock, L., "Research Areas in Computer Communications", Computer Communication Review, SIGCOMM Quarterly Review 4, W. Chu, ed., July 1974, pp. 1-4.
[Communications, Distributed System, Flow Control, Resource Sharing]

The major research areas in computer communications are discussed. The specific problems emphasized by the author are: design of computer communication networks consisting of thousands of nodes, flow control in all networks, and the problems of privacy, security and resource control and allocation in distributed systems.

Lay, W., Mills, D., Zelkowitz, M., "Design of a Distributed Computer Network for Resource Sharing", AIAA Computer Network Systems Conference, Paper #74-426, 1973.
[Distributed Computing, Resource Sharing, Time Sharing, Fault Tolerance, Kernel, Virtual Memory, Interprocess Communication, Message Switching, Resource Management, Ring Network]

A distributed operating system for an integrated network of non-homogeneous minicomputers is proposed. Current distributed computer network designs are discussed. The general organization of the prototype Distributed Computer Network (at the University of Maryland) including storage management, interprocess communication (via messages and ports), and resource management is discussed.

Multics, "System Administrator's Manual", Honeywell Info Systems and MIT, Feb. 1973.
[Accounting, User Support, Management Support]

This document describes the capabilities and functions provided the System Administrator of a Multics system. The facilities described include resource control, billing, creating new users, etc.

Padlipsky, M.A., "Two Solutions to a File Transfer Access Problem", RFC 505, July 1973.
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Padlipsky, M.A., "NETED: A Common Editor for the ARPA Network", RFC 569, Oct. 1973.
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Pogran, K.T., "Unmuddling Free File Transfer", RFC 501, May, 1973.
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This RFC elaborates on the suggestions made in Bressler's RFC 487. The author examines the problem from another point of view and points up several difficulties in security and accounting. Also see RFC's 487 and 505.

Quatse, J., Gaulene, P., Dodge, D., "The External Access Network of a Modular Computer System", AFIPS SJCC 40, 1972, pp. 783-789.
[Resource Sharing, Security, Message Processing, PRIME, Protection, Error Detection, Inter-process Communication]

The PRIME system consists of sets of modules dynamically reconfigured into separate subsystems. Three classes of communications are needed: processor-to-processor, processor-to-facility pool device-(e.g. disk drive), primary memory-to-facility pool device. This paper describes the structure and components of the External Access Network (EAN) developed for this purpose.

Roberts, L., Wessler, B., "Computer Network Development to Achieve Resource Sharing", AFIPS SJCC, 1970, pp. 543-549.
[ARPANET, Resource Sharing, Store-and-forward Networks, Network Topology, Network Design]

This slightly dated article gives the requirements, properties, and topology of the communications system chosen for the ARPANET. A quantitative comparison is made between the chosen ARPANET configuration and alternative network communications systems designs.

Saltzer, J.H., "Protection and the Control of Information Sharing in Multics", CACM 17, July 1974, pp. 338-402.
[MULTICS, Security, Privacy, Access Control, Data Sharing, Time Sharing, Virtual Memory, Storage Hierarchies]

Design principles and goals of Multics, a highly secure time-sharing system, are described. The schemes Multics uses to implement the design goals are described in detail, and a discussion of the tradeoffs and weaknesses of the implementation is included. The design principles and access control, authentication, and protection mechanisms discussed in this paper are important concepts in the field of secure operating systems.

Schmid, H., "An Approach to the Communication and Synchronization of Processes", International Computing Symposium 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1973.
[Process Synchronization, Inter-process Communication, Petri Nets, Resource Sharing, Deadlock]

Primitives for the communication of concurrent processes are introduced. Using these primitives, process systems are split into processes independent of, and processes communicating with the environment, which allows easy transformation of process systems into Petri Nets. Finally, the implementation is discussed.

Schroeder, M., Saltzer, J., "A Hardware Architecture for Implementing Protection Rings", CACM 15, March 1972, pp. 157-170.
[Protection, Security, Access Control, MULTICS, Virtual Memory]

Criteria are presented for the design of access control mechanisms, and the processor mechanisms for implementing protection rings are described. Finally, advantages and possible uses for protection rings are discussed.

Schroeder, M.D., "Cooperation of Mutually Suspicious Subsystems in a Computer Utility", Report #MAC TR-104, Project MAC, MIT.
[Security, Access Control, MULTICS]

A protection scheme based on capabilities and protection domains is described. The scheme is efficiently implementable in hardware and extends the methods developed for and implemented by the Honeywell 6180 MULTICS processor. Impacts of the design on the supporting operating system are discussed.

Somia, M., "Synchronization Problems in a Computer Network", International Computing Symposium 1973, A. Gunther, B. Levrat, H. Lipps, eds., North Holland, 1974.
[Resource Sharing, Co-operating Processes, SOC (Systeme d'Ordinateurs Connectes), Process synchronization, Distributed System, Resource Allocation]

Synchronization problems connected with distributed resource allocation are discussed in relation to computer networks, in particular to SOC (Systeme d'Ordinateurs Connectes). The solution implemented is described, and advantages and disadvantages are discussed. Finally, the applicability in more general circumstances is studied.

Spier, M., Organick, E., "The MULTICS Interprocess Communication Facility", Second ACM Symposium on Operating Systems Principles, October 1969, pp. 83-91.
[Inter-process Communication, MULTICS, Co-operating Processes, Process Synchronization]

The MULTICS interprocess communication (IPC) facility is discussed as it relates to capabilities produced as a result of basic system design. Shared data bases by virtue of unambiguous file system names, lock and unlock primitives, and block/wakeup services for processor multiplexing are the basis for the IPC facility.

Thomas, R., "A Resource Sharing Executive for the ARPANET", BBN Report 2522, March 1973.
[Resource Sharing, User Support]

This describes the RSEXEC system developed for ARPANET TENEX's. The program allows inter-entity functions as described in Bressler's paper (see RFC 441), an environment for file transfer and mail, and maintenance of a list of accessed files.

Watson, R.W., "Some Thoughts on System Design to Facilitate Resource Sharing", RFC 592, NIC 20391, Nov. 1973.
[Distributed System, Resource Sharing, ARPANET]

An appeal is made to system designers on ARPANET hosts to systemitize interfaces to system services. Decoupling the service from a direct link to the local operating system makes it more accessible to other sites located around the network.

Weis, A., "Distributed Network Activity at IBM", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 1-25.
[RJE, Resource Sharing, TSS, Protocol, Centralized System, Distributed System, Security]

IBM experimental network activities, related to TSS, during 1968- 1972 are described. Some of the outstanding problems that will have to be addressed during the coming years in the area of computer networks are discussed.

Wulf, W.A., Bell, C.G., "C.mmp--A Multi-Mini-Processor", AFIPS FJCC, 1972, pp. 765-777.
[Multi-processing, Process synchronization, Resource Sharing, Operating System, Computer Hardware]

This paper describes a multi-processor configuration of Digital Equipment Corporation PDP-11's being constructed at Carnegie-Mellon University. The processor, memory, and switches being used are described. An operating system kernel called HYDRA is introduced, and a very brief discussion of resources and protection is given. Processor synchronization and related software issues are discussed.

Cotton, I., "Network Management Survey", Seventh Hawaii International Conference on System Sciences - Subconference on Computer Networks, 1974.
[Network Management, ARPANET, MERIT, TYMNET]

A brief comparison in table format is presented of management practices for the ARPANET, MERIT, TUCC, Oregon State, and Tymnet networks. All information is from reference material.

Herzog, B., "MERIT Computer Network", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 45-48.
[MERIT, Resource Sharing, Front End Processor, Distributed System, Network Design, Network Management]

The objectives and organization of the MERIT Computer Network are discussed from their inception through their projected future development. The historical and administrative compexities are presented. (author's abstract)

McKay, D., Karp, D., "IBM Computer Network/440", Computer Networks, R. Rustin, ed., Prentice-Hall, 1972, pp. 29-43.
[Distributed System, Telecommunications, Centralized System, Network Control Language]

Network/440 is a heterogeneous, general purpose computer network as well as a research project on networking problems. This paper describes the present design and implementation, and what are forseen as important problems in the field of networking.

McKenzie, A.A., Cosell, B.P., McQuillan, J.M., Thorpe, M.J., "The Network Control Center for the ARPA Network", Computer Communication: Impacts and Implications, Proc. First ICCC, S. Winkler, ed., 1972.
[ARPANET, Network Control, Network Management]

The NCC is responsible for detecting, locating, and correcting failures in the ARPANET IMP communications network. This paper discusses the hardware and software used to accomplish this, along with several measurement facilities.

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Over 400 documents related to network data management and resource sharing are annotated. The documents cover topics in data management, computer networks, operating system concepts, communications, resource allocation, measurement and analysis, front ends, security and application support.

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